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Cost Based Energy Efficient Routing Algorithm for Wireless Body Area Networks

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Abstract- WBAN is a forthcoming technology which utilizes the wireless sensor node to execute real time wearable health monitoring of patient. In such network traffic routing placed an important role together with the positioning of relay nodes which collect the information from children node and send it towards the sink. In this paper we discuss how the wireless body area networks are used in health care relevance by using multiple sensor nodes. The paper discuss the calculation of energy and cost function. Our proposed cost function computes the reliability of path on basis on factor critical. Simulation result demonstrate that over proposed protocol highest energy stability period and cost effective.

Keywords - WBANs, Cost Function, Throughput, Sink, Residual Energy

I. INTRODUCTION

A wireless sensor network (WSN) is a group of miniaturized sensor nodes which are deployed in a field to monitor physical conditions autonomously. WSNs measure a great number of physical conditions like sound, pressure, temperature etcetera. Sensor nodes than pass this sensed data to a base station or sink. The current advance WSNs is bidirectional that also control the activity of sensor node. Today these WSNs are deployed in many industrial applications to monitor industrial process, industrial control and monitoring health of machine. The WSN is composed of 'sensor nodes' which can be few in numbers, hundreds or thousands in numbers. A sensor node in WSN is connected with other sensor node or with several sensor nodes. A sensor node consists of many components, microprocessor or a microcontroller to control the operation of node, a radio transceiver to communicate, and to interface sensors with power source, an electronic circuitry is used. Batteries are normally used as power source in these sensors or energy is harvested from any available source. The size of the sensor node varies according to application, as sensor node can have a size of shoe box or a tiny senor like dust grain. Similarly the sensors have variable cost. The prize sensor node may range from few dollars to hundreds of dollars as a node contain complex circuitry and advance features. Many topologies are used in these networks like simple star topology or advance multi-hop topologies [1] One of the major applications of WSN technology is monitoring of human health [2].In WBAN, only few sensors are used which are implanted in body or positioned on the body. These tiny sensors placed on patient's body measure vital signs like blood pressure, Glucose level, and pulse rate etcetera. These measured values are then forwarded to the medical server or doctor to further analyze the patient's condition. Wireless sensors provide continuous monitoring of patient at remote place. Advancement in wireless technology born a new generation of WSN which is suitable for networking on the human body or in the human body. For data transfer among sensor nodes a point to point topology or multi-hop topology is used in these networks. Use of topology depends on the application, for example to measure the postures of an athlete require a multi-hop topology. The sensed data is exchange among sensor nodes and then it reaches to base station or sink. Sensors can be implanted or placed on the athlete's body.

The rest of the paper is organized in the following order. In section 2, we review related work, Proposed work is presented in section 3, while detail of protocol presented in section 5. Simulation results are presented in section 6 respectively. Finally section 7 gives conclusion.

II. RELATED WORK

Wout Joseph el al. (2011) had proposed Design of Energy Efficient Topologies for Wireless On-Body Channel [1]. The author conclude this paper, metrics and algorithms should be developed that can decide which node to forward to and that allow a node to communicate whether it is capable of cooperating.

Jocelyne Elias et al. (2012)had proposed Energy-aware Topology Design for Wireless Body Area Network [2]. In this paper author conclude that the model can be used to minimize both the total energy consumption and the network installation cost, while ensuring full coverage of all sensors.

Q. Nadeem et al. (2013) had proposed a stable increased-throughput Multi-hop Protocol used Wireless Body Area Networks [3]. In this paper author propose a cost function based on residual energy of node and its distance from sink. Nodes with less value of cost function choose as parent, and other nodes become child nodes. Two critical nodes placed near to sink, so that their energy not deplete early. The results of author shows an improvement in compare to traditional thermal based routing.

Javed Iqbal Bangas et al. (2014) had proposed Reliability Aware Routing for Intra-Wireless Body Sensor Networks [4]. The author conclude that average energy utilization and regular temperature of RAR are slightly high as compared to TMQoS because RAR selects desired next hop based on path loss and steadiness instead of least hop count policy be in used in TMQoS.

Gill R. Tsouri et al. (2012)had worked on Increasing Network Lifetime in Body Area Networks Using Global Routing with Energy using up Balancing [5]. In paper proposed global routing approach allows WBANs to operate efficiently for longer periods of time before recharging of batteries is required.

III. PROPOSED WORK

Our proposed cost function computes the reliability of path on basis on factor critical. This also results in enhancing network lifetime and successful delivery of packets. The working of network is as follow:
Energy factor (Ei) depend upon Remaining Power and Initial power, Cost factordepend upon Vulnerability factor and Energy factor, Vulnerability is computed on basis of distance, RSSI (received signal strength indication) considering probability of movement.

IV. PROTOCOL DETAILS

In this section we present a Multihop routing protocol for WBAN's.the limited number of nodes in WBAN's. give opportunity to relax constraints in routing protocol keeping routing constraints in mind we improve the network stability period and through of the network. Next subsection gives detail of the system model and detail of Multihop protocol.

System model
We deploy sensor nodes on the body at fixed places. We place sink at waist. Sensors for ECG and Glucose level are placed near the sink. Both these sensors have critical data of patient and required minimum attenuation, high reliability and long life therefore; these sensors always transmit their data directly to sink. Other sensors follow their parent node and transmit their data to sink through forwarder node. It saves energy of nodes and network works for longer period.

Data aggregation
Remove duplicity decrease data load high throughput, more residual energy.

Table1: Various Parameters used in Implementation

PARAMETERS	VALUES
Number of nodes	8
Field dimensions	Approximately(human body)
Number of rounds	8000
Initial energy (E_{int})	0.5 volt

Initial Phase
Sink broadcasts its location through short information packet then Sensor nodes store the location of sink. Each sensor transmits short information packet to sink which contains node ID, its residual energy and location. Sink broadcasts information to all sensors.

Selection of Forwarder Node
Minimum cost function value is used to select optimal data forwarder which contributes toward network high performance. A node with high residual energy and less distance to sink has minimum cost function. Computed as follow-
Cost factor depend upon Vulnerability factor and Energy factor
Vulnerability is computed on basis of distance, RSSI (received signal strength indication) considering probability of movement

Scheduling
Forwarder node assigns TDMA schedule to its children node, TDMA ensure least collision. Children nodes transmit their data in allocated time slot. TDMA scheduling saves energy of sensor nodes as sleep use least power. TDMA is used along with data aggregation.

V. SIMULATION RESULTS AND ANALYSIS

To evaluate proposed protocol, we have conducted an extensive set of experiment using MATLAB 2012. We study the performance of old Multihop by comparison with proposed Multihop

Number of Dead Nodes
Fig1.shows the dead nodes WRT rounds for Old Multi-hop and Proposed Multi-hop. The Proposed Multi-hop has shown much better results as the usage of energy in proposed Multi-hop is uniformly used, Fig1 clearly depicts that proposed multi-hop all nodes dead around in same range rounds where, as in old Multi-hop 3 nodes are dead at

3000 rounds where as proposed multi-hop there will be no loss at 3000 rounds. There is only one node dead at 4500 round and 6 nodes are dead at 6000 rounds. It shows that each node consumes almost equal energy in each round and all the nodes die almost at the same time.

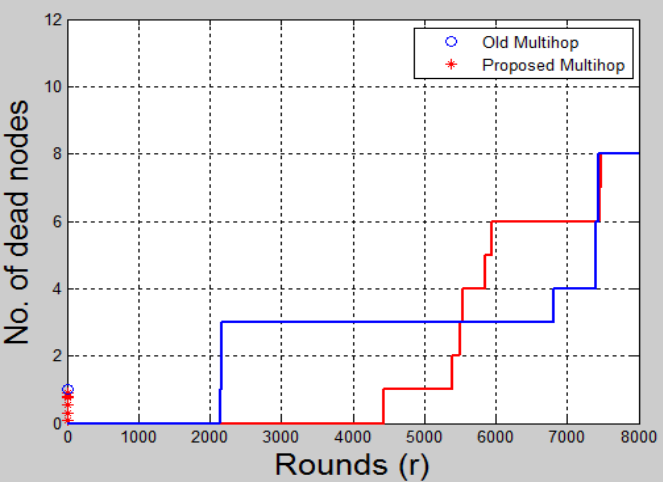

Figure 5.1: Number of dead nod

Data Sent to Sink

In fig. 2, the data sent to sink has shown for both old and proposed multihop. It also signify throughput. The proposed Multihop sent lesser data to sink initially as it use energy in uniform manner. Afterward proposed multihop shows great increase than old multihop because in proposed multihop all the nodes are alive but not in old multihop. WBAN has critical and important data of patient so, it is required a protocal which has minimum packet drop and maximum successful data received at sink. Proposed multihop achieve high throughput then old multihop as shown in fig2. More alive nodes send more data to sink which increases the throughput of network. On the other hand , proposed multihop acheive high throughput due to the longer permanence period.

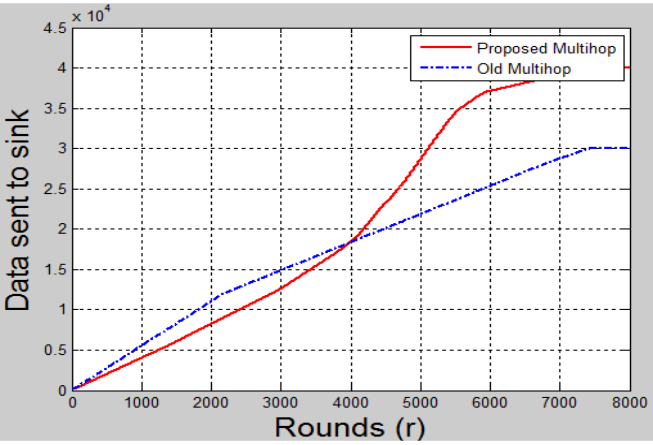

Figure 5.2: Data sent to sink

Data Received at Sink

Fig3 clearly depicts that proposed multihop that the data received at sink shown for both old multihop and proposed multihop. It also signifies that the the data received at the properway. It clearly shows that our proposed multihop as more data are to be achieve and longer network existence time and more immovability period.

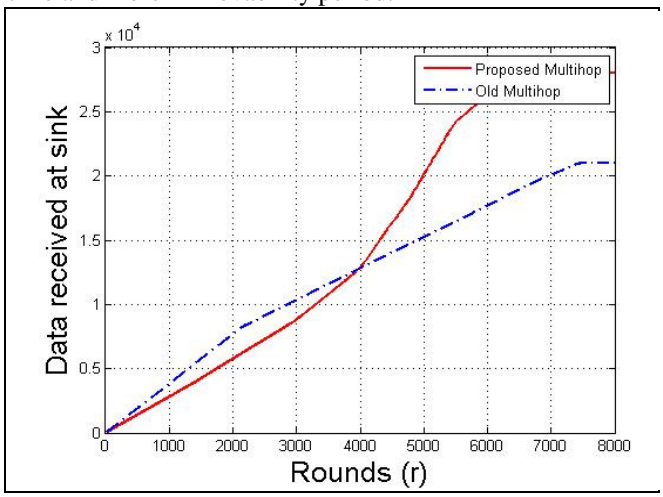

Figure 5.3: Data received at sink.

Data Dropped

The data dropped by proposed multihop is mush higher than old multihop as the compression ratio taken is higher as well as duplicate packets discard is higher. Fig.4 shows data dropped for both old and proposed multihop protocol.This shows that our proposed multihop has longer network living time and longer solidity period.

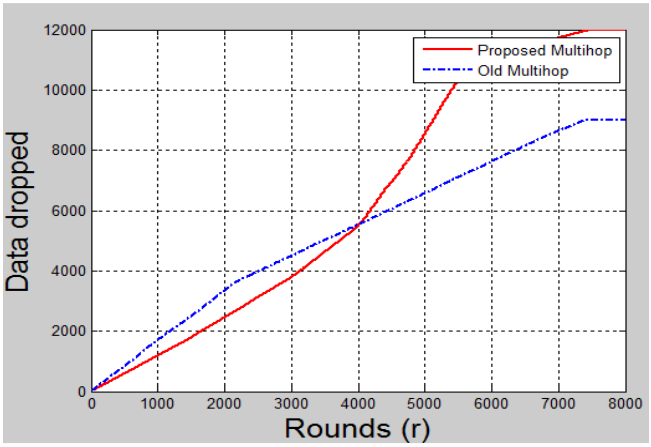

Figure 5.4: Data Dropped

Residual Energy

In figure 5, the residual energy has been shown. The proposed scheme use energy in fair way, results in residual energy left in nodes is same at all points. It enhance network lifetime.The Old multihop use energy at higher rate and in non uniform manner results in steep decline in

residual energy. Simulation result shows that the proposed multihop consume minimum energy till 70% of simulation time. It means, in stability period more and nodes have enough energy and they transmit more data packets to sink. It also improve the throughput of the network. Proposed had uniformaly energy consumption. Making more suitable to use

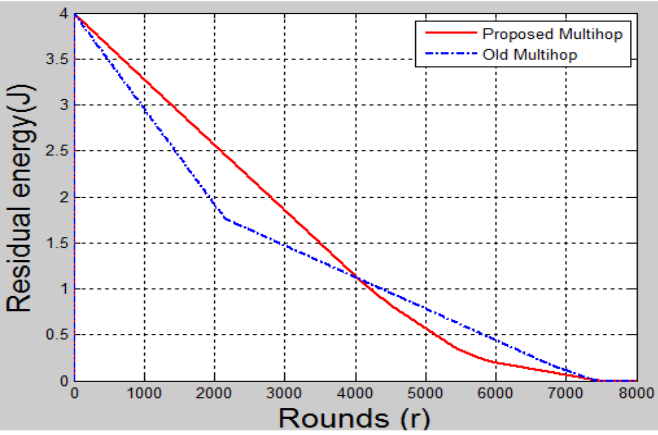

Figure 5.5: Residual energy

Path loss or Dropped

In fig.6 Path loss for old and proposed multihop has shown. The proposed multihop results in less path loss, as it use minimum distance scheme for forwarding. The proposed multihop is better than old multihop in term of path loss. Pathloss shown in fig 6 is a function of distance and frequency. It is calculated from its distance to sink with a constant frequenct 2.4 ghz. Propoed multihop topolgy reduces the path loss in the fig 6 due to fact that multihop transmission reduces the distance which leads to minimum path loss. Initially in old multihop at 3000 rounds path loss dramatically decrease because some nodes of old multihop topolgy die minimum number od alive nodes has mimnmum cummulative path loss as our proposed multihop has longer stability period and more alive nodes has more commulative path loss.

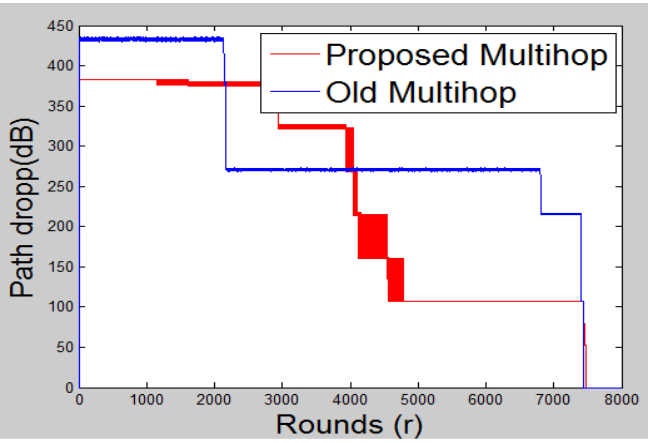

Figure 5.6: Path loss or drop

Delay

The delay for both proposed and old multihop shown in fig.8. the average delay shown by proposed multihop is much lesser than old multihop. It also signify that throughput of proposed mutihop is better,. The lesser delay justify the efficiency of proposed multihop protocol routing in WBAN.

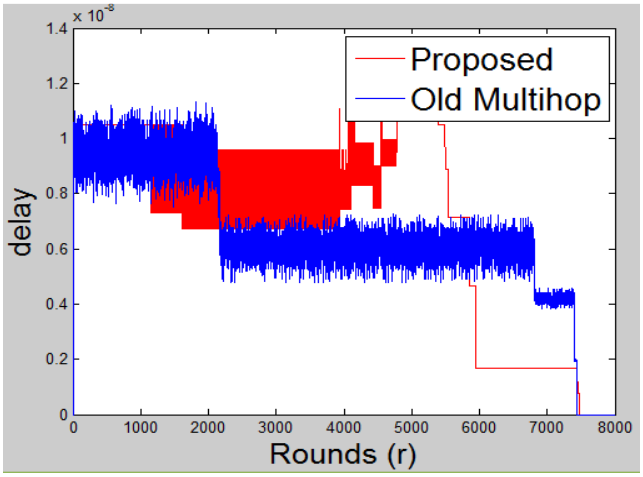

Figure 5.7: Delay

VI. Conclusion

Wireless body area network are widely used for the biggest constraint in WBAN is its battery power, which is responsible for the network lifetime. In our proposed approach an attempt has been made to enhance the network performance by optimal use of residual energy and enhancing network lifetime. The work done is carry forward from Multi-hop routing protocol [3], which is an efficient way of routing in wireless body area networks. The cost function proposed by the author is depending upon distance and residual energy only. This is major shortcoming in case when data transmission load is higher than left residual energy. In this case the energy is wasted and data transmission fails too. Using our proposed cost function, there is significant improvement in performance of network which is computed on basis of various factors like dead node, residual energy, data packets sent and received to sink and delay etc. The results are computed using MATLAB-2012 and simulation study has shown that there is noticeable improvement using our proposed technique.

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