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A ROUTING PROTOCOL BASED ON STABLE INCREASED THROUGHPUT MULTI – HOP PROTOCOL FOR WIRELESS BODY AREA NETWORK

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Abstract: *Wireless Body Area Networks (WBAN) is a part of Wireless Sensor Network. This type of network is consists of small, low power and intelligent nodes. These nodes are placed on, in or around the human body. These nodes are useful for monitoring the vital signs of patient's. Use of WBAN decreases the cost of health care system. These sensors collect data from the body and transmit to the sink. The sink collects the data from the nodes and sends it to the concerned persons. The concerned persons can access the patients' data and issue an advice. WBAN used in health monitoring without affecting the routine activities. In this work, a routing protocol which is based on Stable Increased-throughput Multi-hop Protocol for WBANs has been proposed. This protocol route the data in WBAN. First, a cost function is calculated corresponding to each node which is used to select appropriate route from data node to sink. Cost function is based on residual energy of nodes and their distance from sink. Nodes are categorized as parent node and children node. Those nodes, which have lower value of cost function, are selected as parent node and nodes having higher value of cost function selected as children node. Children nodes are supposed to give their data to parent nodes. Parent nodes forward data directly to sink. Parent node would have high residual energy and minimum distance to sink. Residual energy parameter plays an important role in selection of parent node by balancing the energy consumption among the sensor nodes while distance parameter ensures successful packet delivery to sink. MATLAB R2013a has been used as an implementation platform using its generalized toolbox. Some parameters i.e. number of alive nodes; number of dead nodes, residual energy, path loss, packet received and packet dropped with respect to number of rounds are also calculated and compared with that of existing method.*

Keywords: *WBAN, WSN, Body Area Networks etc.*

1. INTRODUCTION

Wireless body area networks (WBAN) applications have emerged as one of the hottest research areas of wireless sensor networks (WSN). With the advent of miniature, cost effective and wearable sensor devices, WBAN has attracted large amount of research time [9]. It brings out a replacement set of challenges in terms of sensor deployment and density, energy potency, security and privacy and wireless technology [7]. A WBAN is a division of Wireless Sensor Network which consists of small, portable [6], low power and intelligent nodes [4] that are placed on, in or around the human body [8]. These nodes are used for monitoring a patient's vital signs. Use of WBAN decreases the cost of health care system. These sensors collect data from the body and transmit to the sink. The sink collects the data from the nodes and sends it to the concerned persons. The concerned persons can access the patients' data and issue an advice. WBAN used in health monitoring without affecting the routine activities. [1]. WBAN device needs a specific function for ubiquitous healthcare application [2].
WBAN can connect itself to the internet and transmit data to a remote database or server and WBAN application can also be extended into military and sport areas where the soldier or player health status can be monitored [5]. Due to the diverse components that can be connected and integrated, body area networks will be able to provide various functions in healthcare, emergency, work, research, lifestyle, sports, or military [3].

2. WBAN ARCHITECTURE

Figure 1 shows secure 3-level WBAN architecture for medical and non-medical applications. Level 1 contains in-body and on-body BAN Nodes (BNs) such as Electrocardiogram (ECG) – used to monitor electrical activity of heart, Oxygen saturation sensor (SpO2) –used to measure the level of oxygen, and Electromyography (EMG) – used to monitor muscle activity [4]. Level 2 contains a BAN Network Coordinator (BNC) that gathers patient's vital information from the BNs and communicates with the base-station. Level 3 contains a number of remote base-stations that keep patient's medical/non-medical records and provides relevant (diagnostic) recommendations. The traffic is categorized into on demand, emergency, and normal traffic. On-demand traffic is initiated by the BNC to acquire certain information. Emergency traffic is initiated by the BNs when they exceed a predefined threshold. Normal traffic is the data traffic in a normal condition with no time critical and on-demand events. The normal data is collected and processed by the BNC. The BNC contains a wakeup circuit, a main radio, and a security circuit, all of them connected to a data interface. The wakeup circuit is used to accommodate on-demand and emergency traffic. The security circuit is used to prevent malicious interaction with a WBAN.

2.1 CHALLENGES IN WBAN

WBAN showing far more challenges than wired networks towards design of efficient security solution.

- Resource Constraints on Sensor Nodes: Storage, processing, communication and battery life limitations on a sensor node prevent use of costly key management solutions. Energy is the biggest concern because sensor nodes operate on battery and it may not be possible to visit large number of nodes to replace their batteries.

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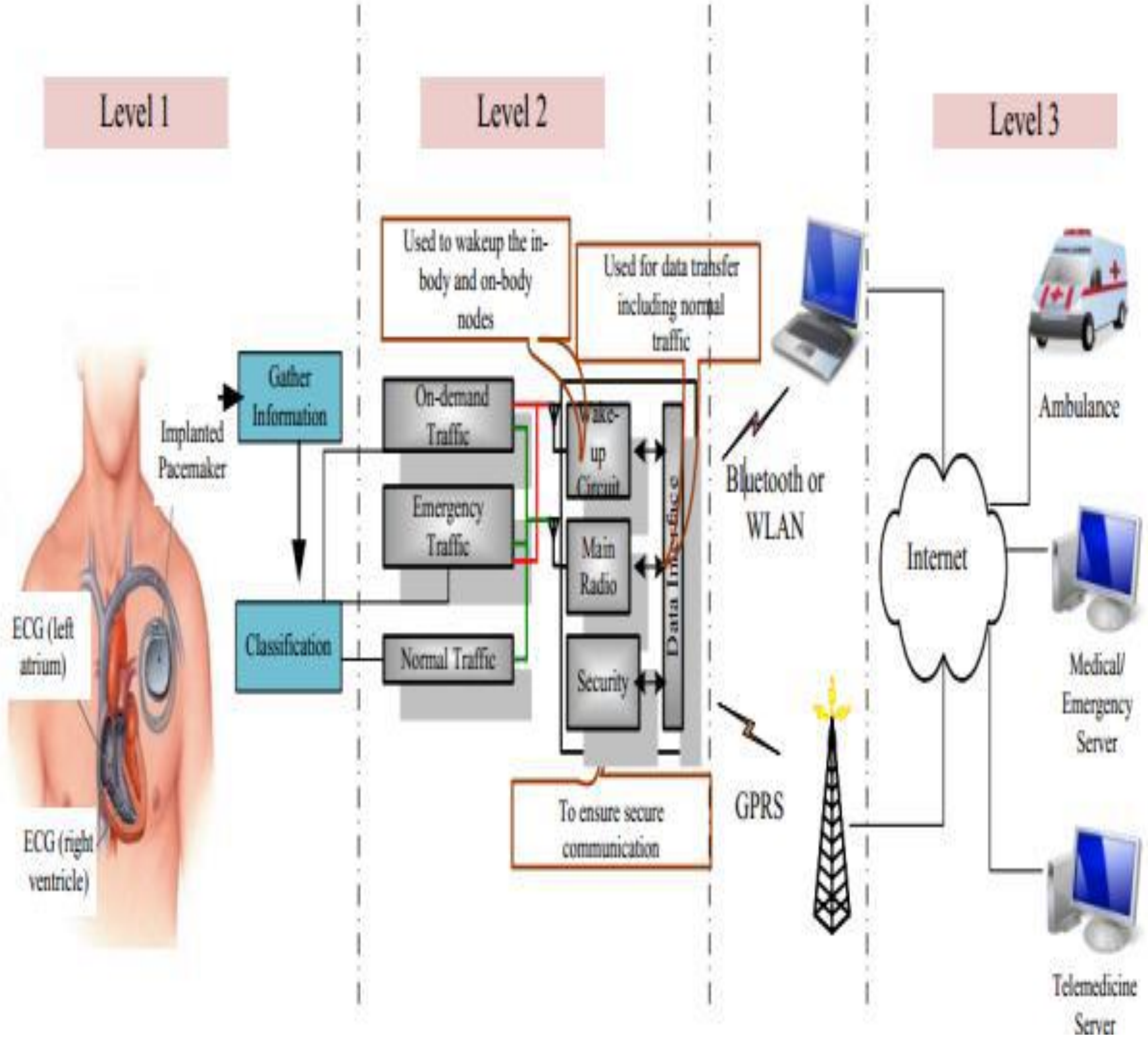

Figure 1: Secure 3-Level WBAN Architecture for Various Medical and Non-Medical Applications [4]

The biggest energy consuming operation for a sensor node is the communication. Thus, security solutions with large communication overhead are not feasible.

- Wireless Nature of Communication: Communication media is the air where everybody has access to. An adversary can perform variety of active and passive attacks on traffic due to broadcast nature of the communication.
- Unknown and Dynamic Network Topology: There is no fixed infrastructure in a distributed WBAN. Although there are resource rich members such as base stations in a hierarchical WBAN, still large amount of sensor nodes are randomly scattered over a target area [10].
- Very large and Dense WBAN: Most of the proposed sensor applications require hundreds to thousands of nodes densely deployed on a target application area.

3. PROPOSED METHODOLOGY

Table 1: Different Parameters and their value for proposed method

S.No.	Parameter	Value
1	*Initial energy*	*0.5 Joules*
2	*Energy dissipated per bit to run transmitter*	*16.7 nJ/bit*
3	*Energy dissipated per bit to run receiver*	*36.1 nJ/bit*
4	*Amplification energy for long distance Emp or multipath loss*	*1.97e-9 j/b*
5	*Data Aggregation Energy or compression energy*	*5 nj/bit/signal*
6	*Initial distance between transmitter and receiver (reference distance)*	*0.1 meter*
7	*Energy threshold value*	*0.1 joules*
8	*Number of Nodes*	*8*
9	*Number of Rounds*	*8000*

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Here some steps which are implemented for Proposed Method:

1. Initialization of some counters (to be used in implementation).
- Total delay
- Total path loss
- Total packets to be received to base station (sink)
- Total packets dropped
- Total number of dead nodes
- Total residual energy
- Total number of allive nodes
- Actual packets received to base station (sink)
2. Declaration of some input parameters
- X-position of sink node
- Y-position of sink node
- Number of nodes
- Initial energy
- Energy parameters
- Energy dissipated per bit to run transmitter
- Energy dissipated per bit to run receiver
- Amplification energy for long distance Emp or multipath loss
- Data aggregation energy or compression energy
- Initial distance between transmitter and receiver (reference distance)
3. Initialization of some indication flag counters
- flag for first death
- flag for tenth death
- flag for all deaths
- round at which total death occur
- round at which first death occur
- round at which tenth death occur
- round at which all death occur
4. Declaration of energy threshold value
5. Declaration of maximum number of rounds
6. Assignment of all nodes as allive nodes
7. Deployment of nodes
- X-position of 1st node
- Y-position of 1st node
- Position far from node (could be parent node)
- X-position of 2nd node
- Y-position of 2nd node
- Position far from node (could be parent node)
- X-position of 3rd node
- Y-position of 3rd node
- Position far from node (could be parent node)
- X-position of 4th node
- Y-position of 4th node
- Position far from node (could be parent node)
- X-position of 7th node
- Y-position of 7th node
- Position near to node (can not be parent node)
- X-position of 8th node
- Y-position of 8th node
- Position near to node (can not be parent node)
- X-position of 5th node
- Y-position of 5th node
- Position far from node (could be parent node)
  - X-position of 6th node
  - Y-position of 6th node
  - Position far from node (could be parent node)
8. Application of Stable increased-throughput multi-hop protocol
9. Declaration of loop according to number of nodes
10. Assignment of initial energy to each node
11. Assignment of identification number to each node
12. Assign each node as child node (0)
13. Calculation of average distance between each node and sink
14. First death indication with round number for each node having energy less than zero (dead node)
15. All death indication with round number for each node having energy less than zero (dead node)
16. Calculation of allive nodes in accordance with current round
17. Assignment of total energy to another variable in accordance with current round
18. Calculation of cost function for each node to select forwarder node using distance between the
19. node and sink the residual energy of node
20. Election of forwarder node with minimum cost function
21. Comparison of energy of forwarder node with threshold value and updation of various counters for forwarder node
22. Calculation of average distance between forwarder node (cluster head) and sink residual energy of forwarder node
23. Calculation of path loss using received power, distance between transmitter and receiver, reference distance, path loss coefficient and Gaussian random variable calculation of delay
24. Forwarding of data from node to neighbors forwarder node and updation of node energy, packet sent to forwarder (cluster head)/base station, delay and path loss
25. Forwarding of data through nodes closer to sink and updation of node energy, packet sent to base station, delay and path loss
26. Direct forwarding of data from node (having energy below threshold) to neighbor forwarder node and updation of node energy, packet sent to base station, delay and path loss
27. Final calculation and updation of total received and dropped packets according to optimal probability
28. Calculating average values of all above parameters
29. Plotting of each parameters with respect to number of rounds

4. EXPERIMENTAL RESULTS

In this work, a system has been proposed which route the data in Wide Body Area Network (WBAN). First, a cost function is calculated corresponding to each node which is used to select appropriate route from data node to sink. Cost function is based on residual energy of nodes and their distance from sink. Nodes are categorized as parent node and children node. Those nodes, which have lower value of cost function, are selected as parent node and nodes having higher value of cost function selected as children node.

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Children nodes are supposed to give their data to parent nodes. Parent nodes forward data directly to sink. We have also suppose that 2 nodes are not eligible for forwarding data as they have critical data to be sent directly to sink and are not suppose to waste their energy in forwarding data. We have taken the snapshot of plot for number of alive nodes, number of dead nodes, residual energy, path loss, packet received and packet dropped with respect to number of rounds. Fig. 2 is the snapshot of average path loss with respect to number of rounds. Fig. 3 is the snapshot of average packet received with respect to number of rounds. Fig. 4 is the snapshot of average packet dropped with respect to number of rounds. Fig. 5 is the snapshot of average number of dead node with respect to number of rounds. Fig. 6 is the snapshot of average residual energy with respect to number of rounds. Fig. 7 is the snapshot of average number of dead nodes with respect to number of rounds.

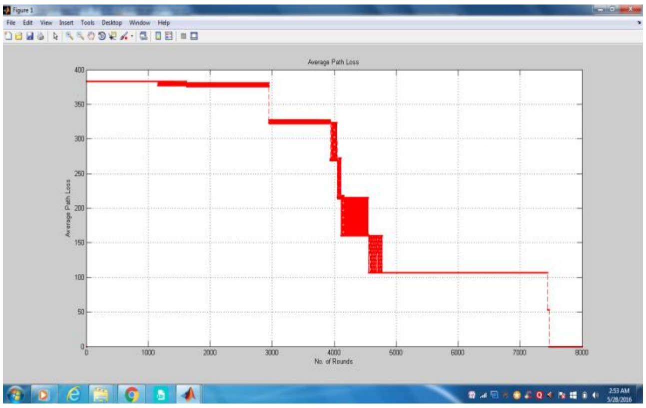

Figure 2: snapshot of average path loss with respect to number of rounds

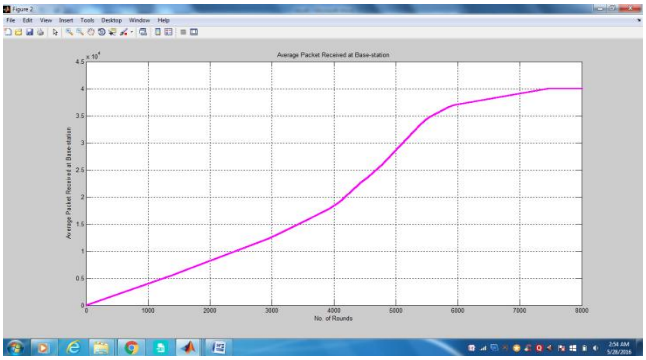

Figure 3: snapshot of average packet received with respect to number of rounds

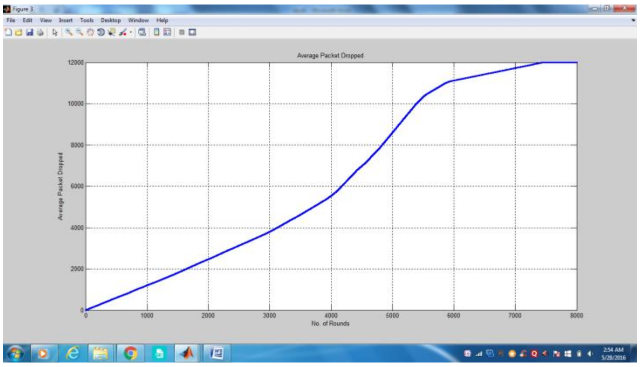

Figure 4: snapshot of average packet dropped with respect to number of rounds

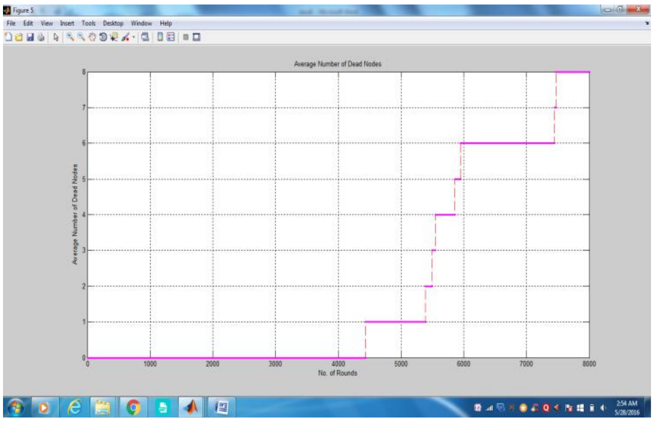

Figure 5: snapshot of average number of dead node with respect to number of rounds

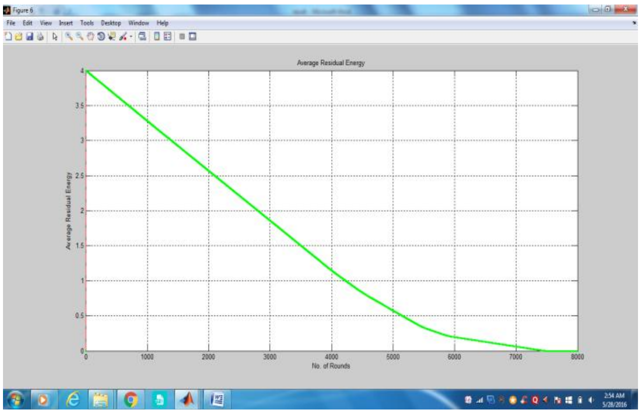

Figure 6: snapshot of average residual energy with respect to number of rounds

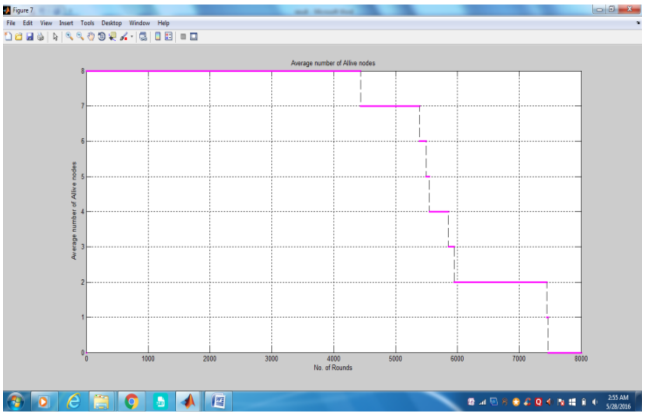

Figure 7: snapshot of average number of dead nodes with respect to number of rounds

5. CONCLUSION

It can be concluded from the whole survey and experimental results that proposed protocol is much efficient as compared to existing method in terms of number of alive nodes, number of dead nodes, residual energy, path loss, packet received and packet dropped. Multi-hop communication is used for transmission of normal data. Single hop communication is used transmission of emergency data. Two nodes are not eligible for forwarding the data as they have critical data to be sent directly to sink and are not suppose to waste their energy in forwarding the data. Threshold based technique is used to select the parent node. If the previous parent node has not much energy and still has energy which is larger than the threshold level, it will remain parent node for the next round. In this way the energy is saved which is wasted to select the new parent node and route the packet through the new cluster. Simulation results shows that proposed protocol increases the stability period, number of alive node at last round and number of packets delivered to sink. Amplification energy required for the communication between base-station to node is very minimum. Also, total dead nodes remain at the end are very minimum.

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