EasyChair Preprint

№ 5914

Dynamic Energy Efficient Body Area Network for cluster based selection of respective higher energy Nodes Mapped to Critically High Nodes through Heuristic Algorithm

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June 27, 2021

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Abstract: In this paper an energy efficient algorithm for node selection applicable for human body area network has been proposed. This algorithm assigns a variable and dynamic time slot for sending information for a certain node connected to a specific part of human body by measuring the level of critical data for the time period along with the static priority of the node. Data-critical level is the most important driver factor for selection of a node; it is being measured by considering upper and lower threshold values of data of the node connected to a certain human organ. After selection of node to sent data, shortest paths are needed to be followed for sending information. The next nodes are being selected through heuristics method. Numbers of clusters are created by grouping sink node data with the next node considering energy level and shortest distance.

Keywords: Body Area Network, Clusters, Data-Critical, Energy efficient, Heuristics.

Introduction

Health care is one of the basic needs for each and every people of a country. There are really scarcity of medical practitioners and health care hub to serve a huge population of a country like ours. In the remote areas of our country always it is not possible to provide proper health care physically. Medical experts always are not available round the clock. Along with that some critical diseases are required to be continuous monitored. Human body area network is a blessing to the continuous health monitoring and proving health care. Human Body Area Network is a radio frequency based wireless network. BAN architecture is working as intra-BAN, inter-BAN and beyond-BAN [1-3]. Wearable sensors are controlled through intra BAN communication, where body to gateway communication is controlled by inter-BAN communication and gateway to medical practitioner's communication is through beyond-BAN. WBAN is IEEE 802.15.6 standard , the network layer is shown in the figure 1. It supports WSNs, Bluetooth, Zigbee and cellular network.[4]

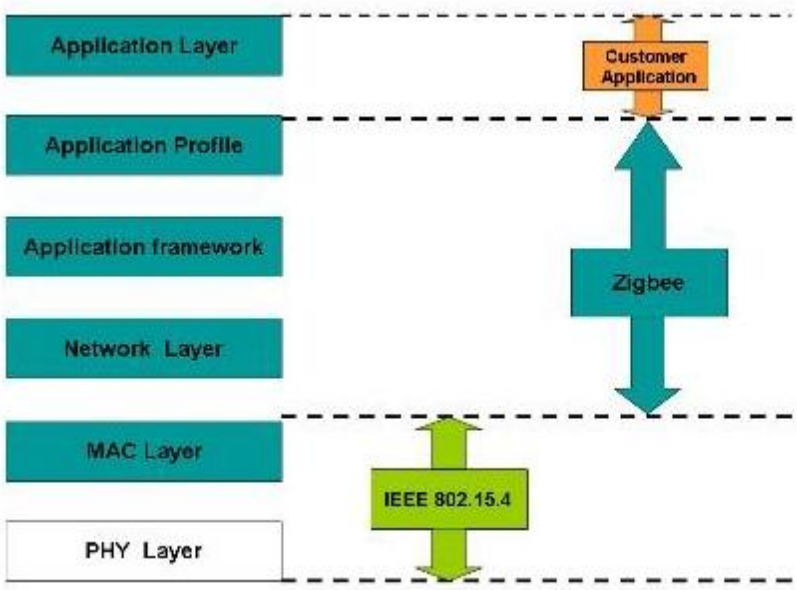

Figure 1: WBAN Layers[.

There are plenty of published work in the field of Wireless body are network. A two phase energy efficient routing algorithm M-ATTEMPT has been proposed [5] Jinhyuk Kim et al have proposed a Dynamic Duty Cycle MAC Algorithm[6]. A new energy efficient and QoS enable routing algorithm has been proposed by Zahoor Ali Khan et. al.[7] . An routing algorithm based on location and residual energy was proposed by
Jyoti Kumari, Prachi[8]. A scalable body area network was proposed by Adnan Saeed et. al. [9] Destination Sequence Distance Vector and Dynamic Source Routing are another two very important routing algorithm.[10-14]. An collision avoidance algorithm has been proposed by Omeni, O et al[15]. Med MAC is another important routing algorithm in the domain[16], it is Adaptive Guard Band Algorithm with drift factor. Low duty cycle MAC protocol is also a proposed BAN routing algorithm.[17]. Three bandwidth management schemes based proposed routing alogorithm in this domain.[18]. Time out MAC is a flexible duty cycle based routing algorithm. H-MAC uses the heart beat for synchronization is another interesting algorithm proposed for this domain.[20]. A scalable and adaptive to traffic load algorithm is Wise MAC[21]. Reservation-based dynamic TDMA is low energy consumption BAN routing methods[22] . PACT is another algorithm having low delay[23]. LEACH, proposed by Heinzelman, W.B et.al is a distributed algorithm.[24]. FLAME is also important routing algorithm[25] prolonged network lifetime algorithm is HEED proposed by Younis, O., Fahmy, S [26] A.B Majumder and S. Gupta have proposed a congestion avoidance priority based routing algorithm.[27].

Proposed Algorithm

The proposed algorithm is divided into two sections one is for the intra BAN where the sending node is selected dynamically depending on criticality of information and next part is for the communication from sink node to the internet where next nodes are being selected through a heuristics process.

Selection of Critical node and assign transmission time

Every nodes are assigning a priority values from 1 to N (lowest to highest) and also assigning weighted value for its data criticality from 1 to N(lowest to highest) dynamically. The level of critical data of node is selected considering the level of deviation from upper and lower threshold values.

1. Every node connected to different body parts of a human sends data in dedicated intervals sequentially.
2. If any node at a certain time has critical data it can suppress other to send data. Level of criticality of data of a node depends on the deviation from the upper and lower threshold values of that certain node.

   Threshold values are : $Tupperi = \alpha i * \big(Ni(AbsoluteValue)\big)$ 1

   $Tloweri = \beta i * \big(Ni(AbsoluteValue)\big)$ 2

   $$where\ i : 1\ to\ N$$

   $\alpha\ and\ \beta\ are\ constant\ whose\ value\ varies\ from\ node\ to\ node$

   Selection of critical node is a function of Threshold values and current values.

   Critical node selection function f(Tupperi, Tloweri,Ni(Data)) checks whether the node data values crossing the lower and upper threshold values.

   $CN = [(Ni(Data) > Tupperi\ )||(Ni(Data) < Tloweri)]$ 3

3. Total transmission time in an interval also depends on the priority and data criticality of the node. The transmission time assign to the nodes are two times of the summation of priority and data criticality value.

   TMi=Tmin*$\log_2 pi + DCi$ 4

   $where\ i\ is\ from\ 1\ to\ N\ , TMi: Transmission\ time\ of\ ith\ node, P: priority\ and\ DC: Data\ criticality\ v$ alue and Tmin is the minimum random value for assigned transmission time.

Selection of path for sending information

4. During path selection mechanism nodes are categorized in to 4 clusters depending on the energy level and sending sensors nodes are also categorized depending on the transmission time i.e data criticality also.
   The sending sensor nodes follows the path of connecting node by mapping its data criticality level with the energy level of the nodes it will save energy.

Clusters of node for sending information N={e1,e2,e3,e4}
Cluster of sensor nodes: SN={DC1,DC2,DC3,DC4}.
Choosing the node for sending data:

Compute Heuristic Function:
F (SN→S) :{{DC1→e1},{DC2→e2},{DC3→e3},{DC4→e4}} 5

Where e1>e2>e3>e4 and DC1>DC2>DC3>DC4.

After mapping is completed for node cluster to sensor cluster it has to find out the minimum distance. The mapping of clusters and finding minimum distance are based on a heuristic algorithm. Choosing of next node with minimum distance and mapping of cluster are not easy as these are not fixed because criticality of data and distance values are not same. So a heuristic mechanism is being used.

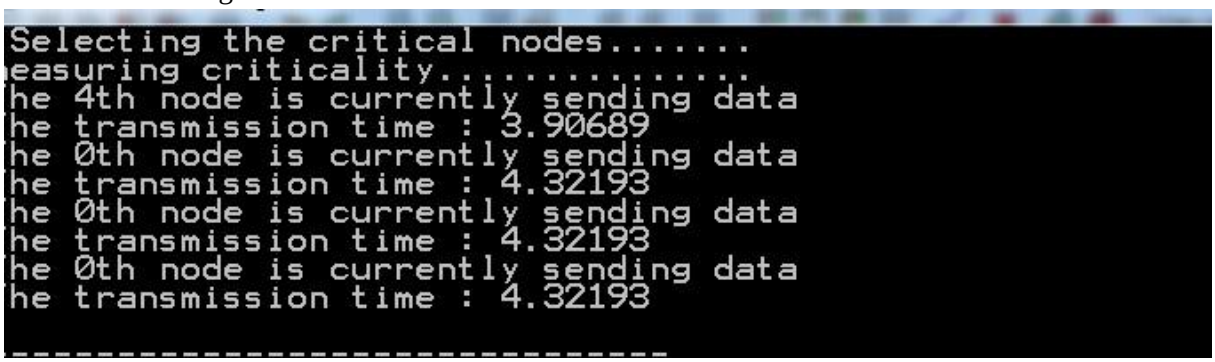

Figure 2: Sample Output for selecting critical node.

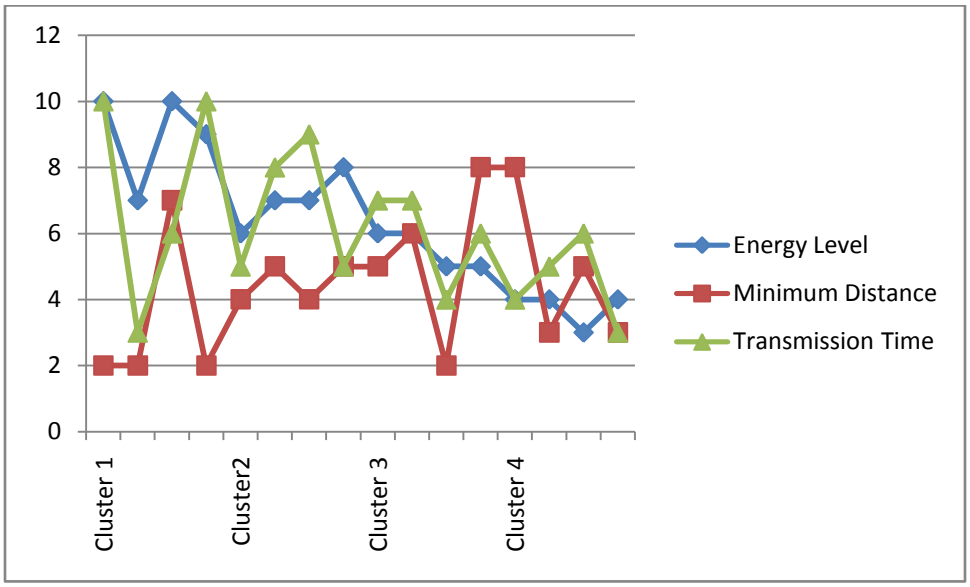

Figure 3: Clustering of nodes .

Conclusion

The proposed algorithm is a dynamic algorithm for sending information by the nodes. Selection of the nodes is based on priority and how critical the information is on the certain time. The selection of next node during the communication from node to gateway is based on a heuristic methodology as the selection of next node is a dynamic process.

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