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Medium Access Controlled Transmit Power Adjustment for Energy Aware Wireless Sensor Networks

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***Abstract* — Transmit power adjustment is one of the key factor for prolonging the life time of the Wireless Sensor Networks. In this paper we present the energy aware MAC protocol which is adjust the transmit power for single hop and multi hop Communication in the wireless sensor networks which is associated with the residual energy and hop count. Sender receives the Hop count information between the sink and intermediate nodes through RTS/CTS handshaking procedure, then compute the transmission power by using the residual energy and the hop count information. The proposed system uses different threshold mechanisms for computing the transmission power. Based on the analytical results, by implementing the threshold levels yield better energy utilization compared to the absence of the same.**

***Keywords* – Transmit Power Adjustment, Wireless Sensor Networks, Single HOP and Multi HOP Communication.**

I. INTRODUCTION

The nodes in the Wireless sensor networks are densely deployed in the area of interest and gather the information surrounded by them. The gathered information further processed and transmitted to the sink by different fashions i.e. cluster head, multi hop by intermediate nodes and so on. Wireless sensor network consist of more number of the data link layer in the OSI model further classified as Logical Link Control and Medium Access Control sub layers. For designing the Energy aware protocol, the MAC sub layer provides better functionalities with minimal overheads [6]. The distance between the any of the nodes in the wireless sensor networks can be computed by received signal strength and hop count between these two. Many of the protocols and algorithms proposed to compute the distance estimation of the wireless sensor networks. The received signal strength calculation may be affected by surroundings of the sensor networks. So it is better to calculate the distance between the two nodes, by the hop count is the optimum way for computing the further process. The residual energy of the sensor nodes may vary from device to device, the node nearer to the sink losses its energy as soon, because this node only forwards the data packet to the sink by receiving the data packet from the far nodes from the sink. Many proposals made to adjust the Transmit power by means of hop count, size of data packet and so on. In our proposed approach the transmit power of small low cost sensors with the limited battery and memory units [1]. Due to the limited battery of the nodes in the wireless sensor network burn out it energy soon, it is a crucial problem to notice that. So it is necessary to prolong the life time of the sensor network, for availing the long standing application requirement. The applications of the wireless sensor networks are forest fire detection, military, surveillance monitoring and so on. The main challenge of the researchers is to minimize the energy utilization and maximize the life time of the wireless sensor networks without affecting the other performance metrics like delay, throughput and etc. The Cost of communication and computation will be determining the energy utilization of the wireless sensor networks [2]. Most of the works in the energy management of the sensor networks fall in the three categories i.e. i) Design of the routing protocols, ii) Design of the Medium Access Protocols and iii) Hardware related designs. In the Energy aware routing protocol design, the shortest path between the senders to receiver will be computed fist and then the data transmission will be made on that particular path only. In the medium access control protocol designs different scheduling schemes were followed and reduce the control overhead thus b y avoiding the unnecessary computational processes. the node is adjusted based on the Residual power of that sender and next nodes hop count between the sink. We proposed different threshold conditions for computing the transmission power, which is used to obtain better energy utilization of the node and thus by increase the life time of the wireless sensor networks.

The rest of the paper described as follows. In section 2 we provide the literature review related to the energy aware wireless sensor networks. In section 3 we present the proposed work with threshold parameters, hop count and residual energy threshold value comparisons. Section 4 provides the performance evaluation of the proposed work and in section 5 we conclude the paper.

II. WELDING SIMULATION

Sau Yee Wong et. al. Proposed the Density – Aware Hop – Count Localization (DHL) in Wireless Sensor Networks with Variable ensity [2]. In the paper the authors propose the DHL for increasing the accuracy of location information where the distribution of node is not in uniform. They implemented the different categories of

range ratio for increasing the accuracy of the distance estimation and minimize the over estimation.

Ying-Hong Wang, et. al. proposed the HMRP-Hierarchy-Based Multipath Routing Protocol for energy aware WSN's [3]. In this paper the authors propose initially the network based on the layered structure, the each node in the network have multipath routes the sink node through parent nodes. The proposed approach distributes the energy consumption among the nodes in the network and thus by minimizes the path loading. In HMRP nodes not necessary to maintain the whole path information and it supports multiple sink node environments.

D.G.Anand et. al., presented the challenges in maximize the lifetime of the wireless sensor networks [4]. In this paper the authors surveys the various energy aware protocols for wireless sensor networks and summarize some of the results in energy saving methods, and they concludes to prolonging the lifetime of wireless sensor network depends on the energy aware Routing protocols and MAC protocol designs and in network processing methods.

Saeed Rasouli Heikalabad et. al. proposed the QoS and Energy Aware Multi-Path Routing Algorithm for Real-Time Applications in Wireless Sensor Networks [5]. In this approach a new multipath routing protocol developed for Quality and Energy aware Wireless sensor networks. This protocol used four main metrics of QoS in path discovery process.

S.Koteswararao et.al. proposed the Energy Aware TDMA Mac For Wireless Sensor Networks [7]. In this approach the authors reduce the energy utilization by avoiding the Re reporting of the data packets i.e. when a node detect an event it wait for some period and verify any of one neighbor already transmit the same event. The waiting time based on the intensity of the event detected, Residual energy of the node and Communication cost to the nearest neighbor on the route to sink.

Akoijam Premita and Mamta Katiyar proposed the A Review on Power Efficient Energy-Aware Routing Protocol for Wireless sensor Networks [8]. In this protocol the authors established the path between the source to destination based on the residual energy of the intermediate nodes and the total number of hop count to the destination. Finally they choose the path which has the large minimal residual energy and minimum hop count.

III. PROPOSED WORK

The proposed algorithm has two phases. First phase is to identify hop count from the next nodes to the sink. Second Phase based on its Residual power, the transmission power will be adjust. Initially Sink node periodically floods the advertisement packet, through which each node in the network identifies its hop count distance from the sink. The hop count information stored in its routing table, and it is updated periodically by the reception of advertisement message from the Sink. Different types of threshold values were fixed to computing the Transmission power adjustment by means of Residual Energy and Hop Count. In this concern a node wish to transmit the data packet, it sends RTS packet to its upstream neighbors and receives multiple CTS from the upstream neighbors. There is one new field added in the CTS packet which is containing the hop count information to the sink.

The sender polls any one of the node from its received CTS based on the different threshold type and compute the transmit power which is based on the residual energy of its own and the received hop count of the neighbors. Only the maximum residual power and minimum hop count nodes allowed transmitting the data packets directly to the sink, and the medium and low level residual power nodes transmit the data packets to the sink by more than one hop.

A. Threshold Parameters

H.C – Hop Count
Th_{RePr} – Residual Threshold Power
Th_{HC} – Hop Count Threshold
$T_{xn}P_r$ – Transmission Power assigned
$T_{xPr}A_{min}$ – Transmission Power Minimum
$T_{xPr}A$ – Transmission Power Allowable
CT_{xPr} – Computed Transmission Power
$E_{initial}$ – Initial Energy
R.P – Residual Power

B. Residual Power Calculation

If the Residual Power is medium level, then

$$Th_{RePr} = E_{initial} / 2 \quad (1)$$

If the Residual Power is minimum level, then

$$R.P < Th_{RePr} \quad (2)$$

If the Residual Power is maximum level, then

$$R.P > Th_{RePr} \quad (3)$$

Red: Residual Power is minimum level
Green: Residual Power is maximum level
Yellow: Residual Power is medium level

C. Hop Count Calculation

If the Hop Count equal to the Hop Count Threshold equal, then

$$H.C = Th_{HC} \quad (4)$$

If the Hop Count Higher than the Hop Count Threshold, then

$$H.C > Th_{HC} \quad (5)$$

If the Hop Count Threshold lesser than the Hop Count Threshold, then

$$H.C < Th_{HC} \quad (6)$$

1. Node has the more residual energy and the sink within its vicinity it uses allowable transmission power and it directly sends the Data packets to the Sink. The Computed Transmission Power will be calculated by the below equation.
   If $R.P > Th_{RePr}$ and $H.C < Th_{HC}$ then
   $$CT_{xPr} = T_{xn}P_r \quad (7)$$
2. If the sender Node has the medium residual energy then, it sends RTS and receives CTS from its neighbors and poll the neighbor one based on the

below condition. The Computed Transmission Power will be calculated by the below equation.

If R.P = Th_{RePr} and H.C = Th_{HC} then

$$CT_{xPr} = T_{xPr}A \quad \text{and} \quad T_{xPr}A < T_{xn}P_r \qquad (8)$$

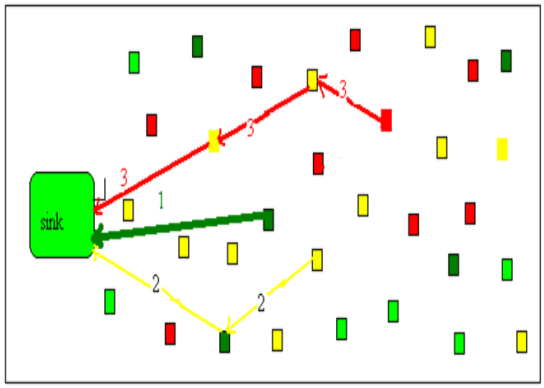

Fig.1. Data transmissions from different residual power level nodes.

Red: Residual Power is minimum level
Green: Residual Power is maximum level
Yellow: Residual Power is medium level

3. If the Node has minimum residual energy, it send the data packet to next up stream neighbor, If the neighbor also having less residual power, it compares which CTS has less hop count to sink, then the node has been polled.

If R.P < Th_{RePr} and H.C > Th_{HC} then

$$CT_{xPr} = T_{xPr}A_{min} \text{ and } T_{xPr}A << T_{xn}P_r \qquad (9)$$

IV. Performance Evaluation

Let us assume the Transmission power of the node is about 20mA, and the battery having initial energy of 3V. The performance of the proposed scenario compared with and without the threshold values. The performance evaluation of the node time versus energy utilization chart as shown in figure 2 and the average energy utilization versus different size of nodes 20, 40, 50 as shown in fig. 3.

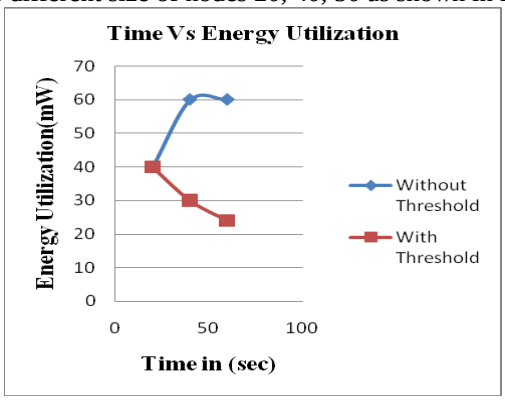

Fig.2. Time Vs Energy Utilization

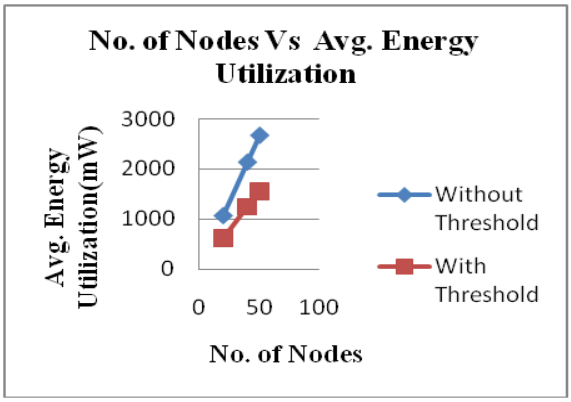

Fig.3. No. of nodes Vs Avg. Energy Utilization

V. Conclusion

We conclude the Medium Access Controlled transmit power adjustment depends on the different Hop Count and Residual Power of the nodes in the sensor networks. Different threshold levels have been fixed for computing the transmission power of the sender. The analytical results shows the computed transmit power prolong the life time of the nodes in the wireless sensor networks. The above figure 2 and 3 gives better understanding of energy utilization of the WSN by using the proposed approach with and without threshold values.

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