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A Power Estimation Method for Energy Efficient Wireless Sensor Network

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Abstract
Wireless sensor networks (WSN) are composed of large number of sensor node with restricted energy. The energy is one of the most important terms in wireless sensor networks problem. Sensor node of WSN consists of processor unit, memory unit and power supply. Wireless sensor node is battery operated, therefore the biggest challenge in field of wireless sensor is the lifetimes of WSN node which can be improve by achieving communication with low power consumption. So in this proposed work, a path metric that accurately captures the expected number of link layer transmission required for reliable end to end packet delivery with minimum number of retransmission are considered; we analytically computed estimated cost with direct data transmission within the node and with shortest path between those nodes. Power is analyzed in terms of minimum cost which is the function of distance, number of packets used for transmission along with numbers of permissible hops. Comparative results are shown between time v/s delay, time v/s direct estimated cost and estimation with shortest minimum retransmission path, with variable data packets rate and number of hops. So, with the proper selection of data packet rate and number of hops for end to end transmission considerable reduction in power consumption can be obtained.

Keywords: *Energy, power, wireless sensor*

INTRODUCTION

The wireless sensor network (WSN) can be formed by using the combination of number of wireless sensor node, these sensor nodes being a micro-electronic device, equipped with a limited power source. In some application scenarios, replacement of power resources might be impossible, thus the sensor node lifetime shows a strong dependence on battery lifetime. In many applications like a multi-hop ad hoc sensor network, each node plays the dual role of data generator and data router. The failure of any nodes can cause significant topological changes in network and might require re-routing of packets and re-organization of the network. Hence, power management and power conservation take on additional importance, so many people are mostly focusing on the design of power-aware algorithms and protocols for sensor networks.

In other mobile and ad hoc networks, power consumption has been an important design factor, but it's not the primary consideration, as the facilities are available such that the users can replaces power resources whenever necessary while emphasis is more on Quality of service provisioning than the power efficiency. In sensor networks, though power efficiency is an important performance metric, directly influencing the network lifetime. Application specific protocols can be designed by appropriately trading off other performance metrics such as delay and throughput with power efficiency.
Power consumption can be broadly divided into three domains:

- Sensing the data

- Communicating the data, and
- Data processing.

SENSING the Data
Sensing power varies with the nature of applications. Sporadic sensing might consume lesser power than constant event monitoring. The complexity of event detection also plays a crucial role in determining energy expenditure higher ambient noise levels might cause significant corruption and increase detection complexity.

Communicating the Data
Out of the three domains, a wireless sensor node consumes maximum energy in data communication. It contains the data transmission and reception. In case of the short-range communication with low radiation power, transmission and reception energy costs are nearly the same. Transceiver consist of mixers, frequency synthesizers, voltage control oscillators, phase locked loops (PLL) and power amplifiers, which all consume valuable power. It is important that in this computation, we not only consider the active power but also the start-up power consumption in the transceiver circuitry

Data Processing
Energy expenditure in data processing is much less compared to data communication. The local data processing is crucial in minimizing power consumption in a multi-hop sensor network. Complementary metal oxide semiconductor (CMOS) technology is used for the micro-processor but it has in-built limitations on energy efficiency. The most straightforward application of a wireless sensor network is to monitor remote environments where hundreds of sensors configured themselves to form a network and immediately report upon detection of any event. In some classes of applications highly dense sensor deployment and reasonably accurate localization may be required, Use of WSN can be an efficient, low-overhead method of data delivery if it reasonably assume enough network density, proper localization and high link reliability independent of distance within the physical radio range.

The goal of power control mechanisms is to dynamically adjust the nodes' transmission range for maintaining some property of the communication network and to save network energy for maximizing network lifetime.

RELATED WORK AND BACKGROUND
A new WSN node energy model [1] has been proposed, based on the event-trigger mechanism. It can be used to analyze the energy status of WSN nodes and systems and to evaluate the communication protocols which can be used to deploy wireless nodes for WSN applications A WSN node model [2] is proposed and analysed for the energy consumption in wireless sensor networks. They estimated the lifetime of sensor node and found that the proposed battery powered sensor node has the estimated lifetime of about 6.5 months for 10 times sensor firing per hour.

The transmission algorithm consists of two components: a binary decision based transmission which can transmit data only when the channel quality exceeds a specified threshold, this can done with Markav decision process. Second component is channel-aware back off adjustment which is introduced to favour nodes with better channel conditions. Combining these two component transmission in proposed [3] algorithm is to maximize energy efficiency.
Performance evaluation based on our simulation experiments has demonstrated [4] a significant energy-distortion-encryption performance gain from the proposed approach compared with the

existing techniques for encrypted wireless video streaming.

Various configurations of Hamming codes, RS codes, and CCs has been explored using this framework. Then proposed a methodology [5] for various ECCs based on a comprehensive energy model of a sensor node. The deployment-related parameters like distance, bit error rate, path loss exponent and the modulation scheme and ECC parameters. This framework considers the three energy components the signal, the circuit, and the computation energy which computes the radio energy and the computation energy. Hence, this result shows that the energy trade-offs in radio and computation energies save up to 60% energy of the sensor node. The exploration results show that, as compared to the not coded data transmission, the energy-optimal ECC saves 15%–60% node energy for the given parameters. Proposed model [6] is applied on a WSN based on cooperative clusters to obtain the outage performance and the cooperative WSN energy consumption are analyzed under the hypothesis that only a set of sensors are awake.

Propose a flooding method [7] that takes into account the characteristics of the existing DSR protocol to conserve power. They confirm the effectiveness of this method with simulation experiments. The experiment has two variables, which is cache data time to live and the parameters of the proposed method to evaluate power consumption and delay. The results indicate that the delay is increased somewhat, but the amount of power consumed is reduced. The energy-efficient maximum lifetime algorithm (EEML) [8] in wireless sensor networks. The utility of energy improves by changing the activity of wireless communication module of sensor nodes such as energy model and state transition of sensor nodes, and employs this subset of active sensor nodes to build a routing tree for transmission, for the processing, dynamic computing the energy consumption to determine one node whether or not is active to prolong the network lifetime. Simulation results show that EEML has better performance than envelope elimination and restoration (EER) algorithm for wireless sensor network.

An accurate power consumption model for wireless sensor node is proposed [9] in which the power consumption of each component in WSN node is assumed constant; only the energy dissipation of circuits takes into account in practical physical layer. Other parameters such as data rate, carrier frequency, RF output power which has a significant effect on the WSN node with the metric energy per useful bit (EPUB). By adjusting one or more of these parameters, then proposed optimal design method to make the network energy efficient. The efficiency of the strategy was validated by mathematical analysis and simulations.

Firstly analyzed all kinds of factors of the energy consumption sources with the digital processing and radio transceiver units being emphasized. Then proposed [10] the design scheme of energy-aware wireless sensor network (GAINS) with an ultra-low-power processor and current energy efficient techniques, such as DVS and modulation scale. They also developed our operating system, compiler and protocol stack.

During transmission, relay sensors jointly encode their own sampled data and the data received from upward sensors. The consumed energy of the network is minimized through optimally choosing the location of sensors. So that proposed the system [11] to balance the consumed energy between different sensors. Which combines the correlation between data and the amounts of data transmitted by different sensors, to make the transmitted energy consumed by different sensors tend to be uniform by adjusting the distance between sensors.

An architectural level optimization [12] which brings a major power reduction due to the fact that any changes made at this level of abstraction will be reflected back to the lower levels, all other levels must be also considered in an overall power reduction strategy. It also addresses different communication protocols and their effect on the power consumption of a wireless sensor node. Analyzed the best modulation strategy [13] to minimize the total energy consumption required to send a given number of bits. Design an energy efficient and reliable interconnection architecture [14] requires careful optimization at all layers of the design hierarchy. Introduce the design [15] of physical layer aware protocols, algorithms and applications that minimize energy consumption of the system.

PROPOSED WORK

Computing Estimated Cost

In this proposed work, firstly find the Euclidean distance between the nodes. We illustrate this estimated cost with example. The Euclidean distance between node p and node q is the length of line of segment connecting them pq.

In Cartesian co-ordinates p = (p_1, p2, p3.......p_n) and q = (q_1, q2, q3......q_n) are two points in Euclidean n-space, then distance between points from p to q or between points from q to p can be calculated as:

$$d(p,q)=d(q,p)=\sqrt{(q_1 - p_1)^2+(q_2-p_2)^2+\ldots\ldots(q_n-p_n)^2}$$

The position of a point in Euclidean n-space is Euclidean vector so p and q is Euclidean vector. From this equation, we can compute the estimated cost between any source node and destination node of the wireless network.

Computing Estimated Cost with Shortest Path Algorithm

Generally, the radio subsystem requires the tremendous amount of power. Therefore, it is convenient to send the data through radio link when required and it is useful to consume less power by sensor itself. The hardware should be designed to allow the microprocessor to judiciously control power to radio, sensor and sensor signal conditioner. All components of the sensor node required particular power level but large amount of power consumption within transmission-reception of the signal in wireless sensor network. This can be done by evaluating the shortest cost path routing algorithm with the minimum hop is proposed which uses link cost that reflect the communication energy consumption rates. In this proposed work, firstly calculate the Euclidean distance between source node and destination node and evaluate the cost, after that calculating, the Euclidean distance between source node and destination node considering the intermediate node and evaluating cost with shortest path which require less power. By calculating the shortest path with the minimum hops on every node, thus saving both transmission and reception power. Power is analyzed in terms of cost means

Cost = Traffic (packet rate) ×Distance (meter)

We analytically comparing estimated cost and estimated cost with shortest path; we can predict which methods require less power. Compare the cost estimation with variable data packet rate and number of hops.

Table 1: *Comparative table for variable packet rate given below: For no. of packet=20.*

Source-> Destination	Estimated Cost	Estimated Cost With Shortest Path	Efficiency %
1->17	1508.06	526.43	65.09
2->24	65.32	65.36	
3->27	3475.55	477.81	86.25
4->32	1871.57	130.68	93.01
8->27	3506.87	462.03	86.82
2->26	1873.71	373.36	80.07
7->32	1663.28	2648.70	
6->28	79.73	102.57	
5->25	194	334.14	
6->29	1241.01	1593.59	

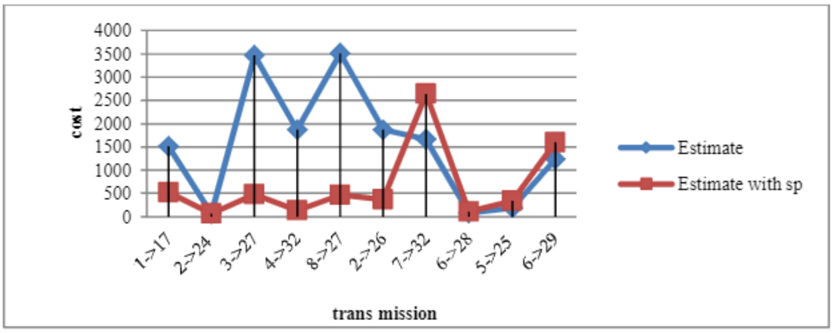

Figure 1: *Graphical representation between transmission path & Cost.*

Table 2: *From the above table comparison between the estimated cost and the estimated cost with shortest path. For no. of packet=30.*

Source->Destination	Estimated cost	Estimated cost with shortest path	Efficiency %
1->17	2502.65	107.14	95.71
2->24	2982.05	1998.18	32.99
3->27	2171	735.05	66.14
4->32	2404.33	1189.73	50.51
8->27	1715.71	679.81	60.37
2->26	2951.0	1998.14	32.28
7->32	2503.28	584.05	76.66
6->28	2050.13	188.11	90.82
5->25	2581.15	675.21	73.84
6->29	1759.17	568.65	67.67

Table 3: *Comparative table for variable number of hops given below: Max hop=20.*

Source->Destination	Estimated cost	Estimated cost with shortest path	Efficiency %
2->24	195.95	1785.52	
3->27	2502	378.44	84.87
4->32	2792.31	2559.60	
8->27	2841.66	393.67	86.14
2->26	2697.74	360.76	86.62
7->32	3329.26	436.09	86.90
6->28	3217.47	3220.96	
5->25	1605.67	164.38	89.76
6->29	1415.71	3220.96	

Table 4: *Comparative table for variable number of hops given below: Max hop=25.*

Source->Destination	Estimated cost	Estimated cost with shortest path	Efficiency
1->17	2021.57	161.85	91.99
2->24	992.03	769.31	22.45
3->27	3581.65	427.98	88.05
4->32	2167.83	841.15	61.19
8->27	3265.54	2262.77	30.70
2->26	*1525.53*	769.31	49.57
7->32	1880.71	2527.33	
6->28	2300.81	1130.01	50.88
5->25	3192.69	1347.64	57.78
6->29	2997.36	1130.01	62.29

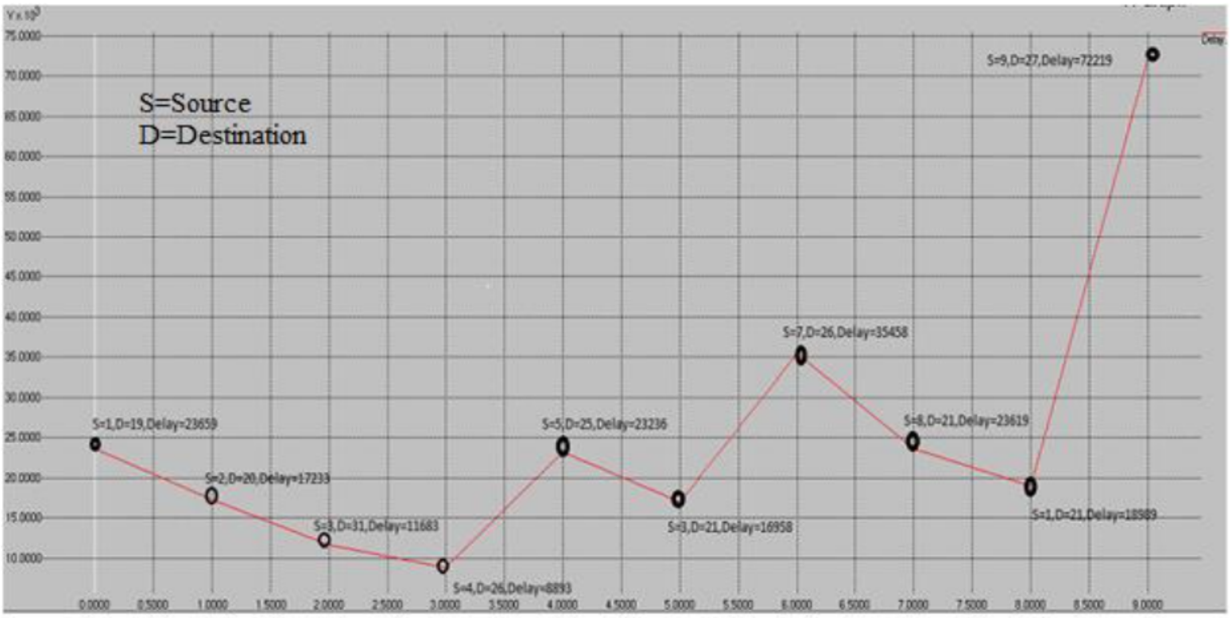

Figure 2: *This graphical representation show how Delay required, which is plotted delay versus time*

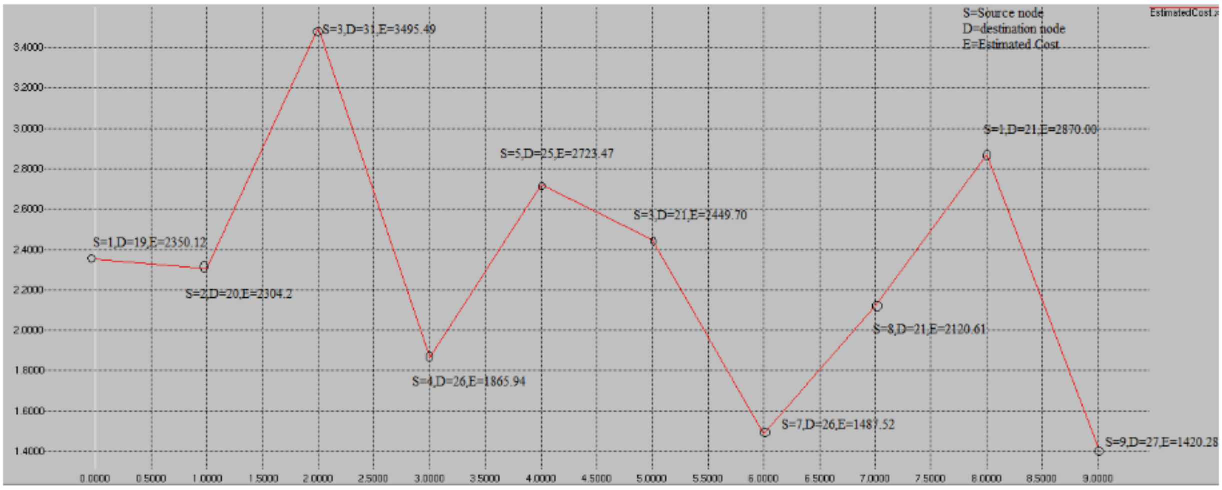

Figure 3: *This graphical representation is initialized with estimated cost that means estimated cost with help Euclidean distance formula.*

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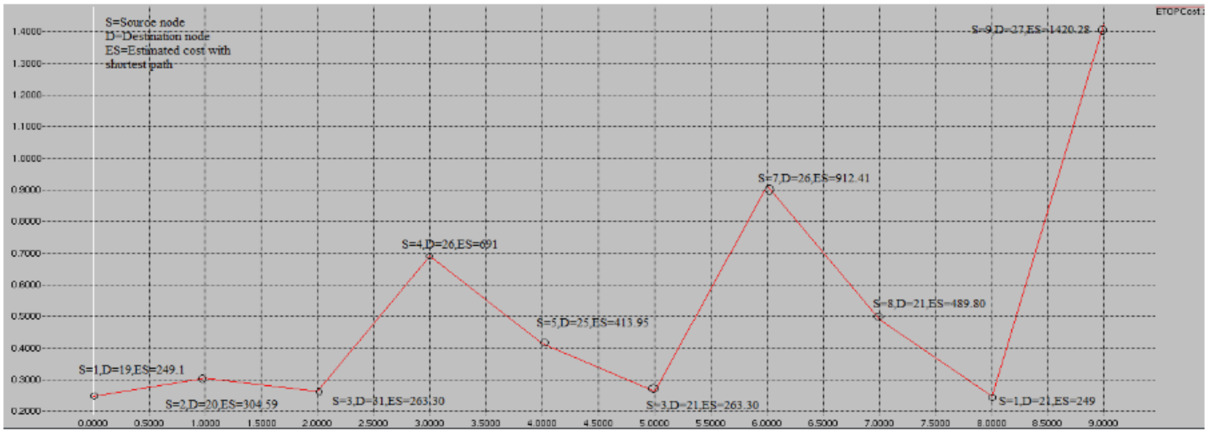

Figure 4: *The graph of estimated cost with which is plotted between cost and time.*

The shown in Fig. 4 is the graph of estimated cost with which is plotted between cost and time. From graph shown in Fig. 3 and Fig. 4, we analyze that estimated cost with shortest path require less power than estimated cost.

CONCLUSION

In this proposed work, power is analyze with respect to cost. In this work, the distance between source node and destination node using Euclidean distance and computing Estimated (Normal cost) after computing the estimated cost applied or computing the estimated cost with shortest path algorithm and analyze these two results which accurately measures the cost, then we can make conclusion that estimated cost with shortest path has less cost than that of estimated cost, which shows that after applying the estimated cost with shortest path which require less power than estimated cost.

FUTURE SCOPE

In future work, we will concentrate on the following aspects. Firstly, we plan to study the hardware design on sensor node and we analyze the various sensor such as passive sensor, Omnidirectional sensor, active sensor etc. which is more reliable for data sensing and data transmission.

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