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Enhancement of Network Lifetime for Wireless Sensor Networks with Mobile Sink Node

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ABSTRACT

Due to the importance of the wireless sensor network in the applications of daily life, especially medical, military and agricultural, the process of developing this type of networks to overcome the problems in use, as the most important of these problems is the problem of energy consumption. The development of the performance of these networks continued to ensure the lowest energy consumption to ensure that they last as long as possible. In this paper, proposed algorithm choose choosing best location for mobile sink according to nodes to save power of these nodes by generating random position. The results in the search show how to represents network model to increase network lifetime. The results indicate the superior performance of the algorithm in improving power consumption with specific conditions and compare energy consumption with other researcher works.

Key words : wireless sensor network (WSN); mobile sink (MS); energy consumption, network lifetime.

1. INTRODUCTION

The sensor network is known as small compact devices with wireless communication capabilities that interact directly with the surrounding environment through sensors that detect many natural phenomena such as temperature, sound, humidity, lighting, pressure, fatigue, tilt, gas sensors, pollution, sugar level,…etc. These devices are known as wireless sensors, WSNs are easy and fast deployment & response, self-organizing, fault tolerance, etc. These devices work together to communicate wirelessly sensed data to the monitoring station, which collects physical data for analysis and takes the necessary measures [1][2][3][4].

Generally, power consumption for WSNs technologies are different from one to another, it is low for zigbee and wibree while it is medium for Bluetooth and high for Wi-Fi technology.

Given the large number of applications that use wireless sensors, scientific research has continued to try to reduce the problems that hinder the use of this type of network, especially the issue of energy consumption that threatens the life of the network in general.

Figure 1a shows a pattern of energy consumption during five different states, which gives a clear picture of the quantities of energy consumption during the processes, which depends on the type and specifications of the processor, the amount and type of data to be sent, the type of sensor and its efficiency, the frequency used for sending and receiving, the power of communication, etc. power consumption in various aspects for each node in WSNs starting from sense the events, process it, then transmit the data packets to sink node or base station through single or multiple hop to destination.

This paper is structured as the following: part two defines WSNs is design to Work and energy consumed to communicate from source to destination, then part three discusses various techniques to increase Network lifetime is depends on energy level, transmitter and processing power of node, and memory, part three presents network model and problem formulation. Part four contains experimental and numerical results. Part five concludes summery reports of results of various energy saving techniques regarding to paper.

The energy consumed sample calculation depends on [5], a figure 1-a- presents the relation between power consumption in each parts of communication system. Constant resistance of components communication material in Figure 1-b, which will later demonstrate using in 3 and 4 later by calculating power consuming during transmission.

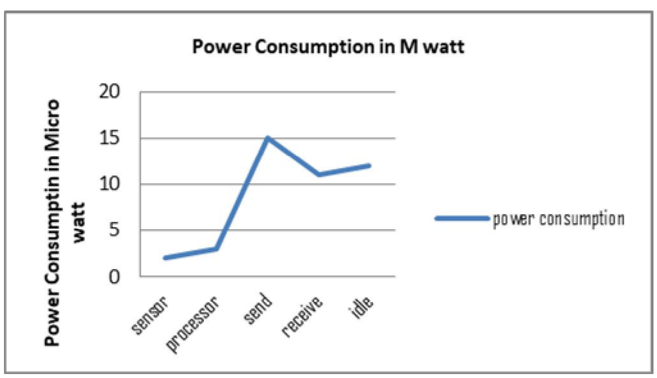

Figure 1a: A example of Power Consumption for WSN in micro WATT

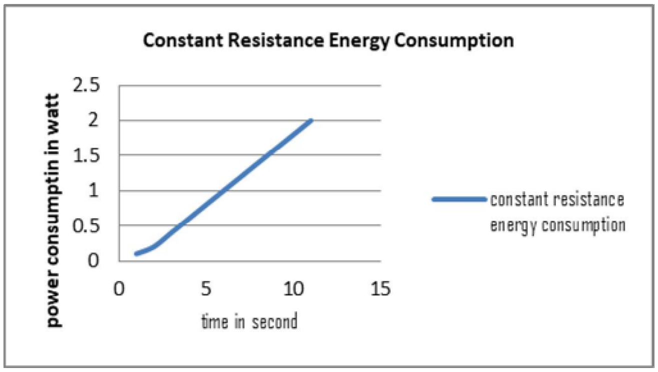

Figure 1b : A WSN example of Power Consumption in micro WATT

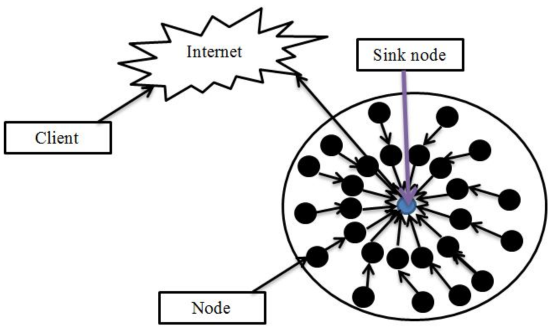

Figure 2: WSNs Sample Architecture

2. RELATED WORK

Mechanisms for node deployment using multiple sink positioning and routing to maximize the network lifetime [6] or in [7] mobile sink based multiple sink balance fairly the load among all nodes while one or more number of mobile sink in which power distributed evenly among mobile node.

To avoid depend on node near sink in [8] which solved by [9] by mobile sink trajectory and path constrained in [10].

Results in [11] show that direct proportion with the increase of the mobile sink number and network lifetime.

Authors in [12] are proposed the maximization of lifetime and minimization of delay for the performance of wireless sensor network. In [13] EEMSRA "an Energy-Efficient Mobile Sink Routing Algorithm" Cluster based model is one of the heuristic algorithm proposed to increase network lifetime by balancing the energy.

There are three types of sinks in WSNs which it is different in speed and direction of mobile sink:

First: random moving used in [14][15],such as almost distributed random trajectory selection. Second: fixed path moving [16][17][18][19][20],such as TPDG "Tour Planning for Mobile Data Gathering" Third: controllable moving [21][22] such as LBDG Load Balanced Data Gathering Algorithm" , also new method had been proposed in which energy balanced tree based data collection with mobile sink had been proposed [23] such as ETDC "Energy Balanced Tree based Data Collection" gathering sub-tree from root and suppose it as traversal with trajectory moving of sink in another words it combine the advantages of three types above as author mentioned.

Simulating the distributed algorithm in [24] improve network by schedule the packets via links with data rate. One of routing protocol in mobile sink is in [25], battery power managed in [26] to increase network lifetime.

There a lot of techniques to enhance Network lifetime such as:

1) Solar powered battery which used as resource to energy of sensor nodes, bad weather condition is biggest problem for this technique [27],

2) Node Reliance Techniques which simple to implement and fixed path and overhearing problem as in[28].

3) Multi-Hop Hierarchical Clustering (MHHC) in [29] the powerful of this technique is hierarchical level sequence of different static path. Disadvantages of static path same nodes in communication, it led to . energy level for all nodes is low energy level simultaneously.

4) Duty Cycling and Data Driven Approach is in[30] one major issue is overhearing with problem of doesn't match between sending in action.

5) SPIN protocol is not suitable for large network as in [31] with problem of blind forward and inaccessible of data.

6) Rendezvous algorithm [32]: the problem of this technique is latency in data collection.

Dynamic routing path selection based clustering designed for Mobile sink in [33] due to low computational using buffer residual energies.

3. NETWORK PROSED MODEL AND PROBLEM FORMULATION

3.1 Problem Definition

There are relation between number of nodes and traffic send through whole networks which should be collected frequently from each particular node to send packet.

Mobile sink supposed to be one of the solutions for this problem also it should be adaptively managed with changing position to save power by managing transfer of packets from sender to end user in case of monitoring or any other WSNs applications.

3.2 Network Model

Figure 2 demonstrates network model by groups the nodes as concepts based its random portion within circle shape deployment, sensor nodes had unique id as {n1, n2,….,nn} with fixed portion within network, same initial and transmit/receive power which depend on distance between sender and receiver, also it gets its location or any other technique.in mobile sink side wireless access any node within network with no restricted power , free movement, and constant speed.

3.3 Energy Model

Sink gathering and exchange the data with spring manner to center of coverage area, energy transmission consumption and reception consumption is calculated for L- bit packet length as shown: in formula 1:

$$E_{Tx}(l,d)= \begin{cases} L.E_{elec} + L.\alpha_{fs}.d^n \text{ if } d_i < d_{i+1} \\ L.E_{elec} + L.\alpha_{amp}.d^n \text{ if } d_i \geq d_{i+1} \end{cases} \quad .... (1)$$

where E-elec. for transmitter or receiver represents electronic energy consumption, di: distance from specific node to sink, d_{i+1}: distance after movement of node as in table 2 listed in section 4, n is number of nodes, α_{fs}, and α_{mp} denotes the amplification coefficient for the free space model and the multi path fading model has been supposed to work in this paper, and d_i is distance of single hop communication.

Reception consumption can be calculated as is shown in formula 2:

$$E_{rx}(l)=(L.Eelec) \quad ..... (2)$$

The following equations used to calculate new energy node, movement consumption energy, remaining energy per node, and remaining energy for each node consequently.

$$New\ energy\ node_i = initial\ energy - MCE. \quad .... (3)$$

MCE. is represent Movement consumption energy

$$MCE. = L.E_{elec} + L.\alpha_{amp}.d^n \text{ if } d_i \geq d_{i+1} \quad .... (4)$$

$$REi = New\ energy\ node - STML * MCE. \quad .. .. (5)$$

Where: STML is abbreviation of *sink time in specific location (in case of movement)*

$$REi = \sqrt{\frac{\sum_{i=0}^{N}(initial\ energy - RE.)^2}{N}} \quad .....(6)$$

Where RE.Remaining energy, i: nodes start with 1 end with 250,other parameters assigned table 1 in section 4.

3.4 Proposed Procedure

Distance from node to mobile sink is limit the energy consumption during data transmission the packet to nearest next arrival of the mobile sink node location [20][34].The following phases are needed to perform the proposed algorithm for Energy calculation with mobile sink:

Input: N: number of nodes in the proposed Network
1. Sink calculates distance for each node by specifying location of each particular node.
Mobile sink. Gets (each node positions) by sending request then calculates each time of replying.
2. Mobile sink collects node position by x and y points.
3. For i=1:N
4. i. Send to mobile sink (packet (i. remaining energy, i. position))
5. Distance to mobile sink (i) = distance (i. position, position)
If (i. Lowest distance) → allow it first → send data to sink
If (i. Equal distance) → fattest reply time → send data to sink
If (i. highest distance) → allow it first → send data to sink
6. Repeat step 3
7. End 3
8. Minimum remaining node energy= remaining energy.
9. end .
Output: optimal mobile sink compared with previous method with low power which proved in section 4.2 later.

4. SIMULATION AND NUMERICAL RESULTS:

Simulation presents a simulation based numerical for power consumption from node towards mobile sinks, Simulation built discrete time based statistics calculations which show impact of changing radius to a mobile sink on network life time.

The sensor nodes assumed to be distributed randomly with fixed portion to its sink , performance measuring network lifetime via sample network with parameters listed in table 1 nodes while in figure 3 above covers 250 nodes , packet=1 byte, specific grid size, and limited power according to transmit/receive packet and start up power required to show time rate.

Results depend on movements for specific node from its portion to next portion which will demonstrate later in section 4.2 and according to direction shown in figure 2.

4.1 Network lifetime

Network lifetime calculate in figure 3 which calculated based equation (7) below by presenting deplete power for nodes deployments through networks. It collects data from various locations, a far radius node from sink should not effect on network lifetime.

$$network\ lifetime = \frac{initial\ energy\ level\ of\ node\ i}{energy\ consumption\ of\ node\ in\ each\ rounds} \quad .....(7)$$

Energy consumption of node in each rounds calculated using equation (1).

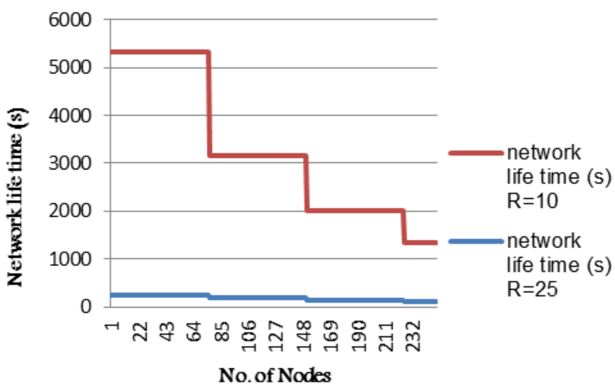

Figure 3: Network lifetime

Parameter	Value	Unit
Number of nodes	250	
Moving speed of sink	3	m/s
E_{elec}: Electrical energy consumption	5e -13	J
L: Packet length	1	bit
Communication radius nodes	15,30	m
Number of path loss length from source to sink	4	
Time interval of packet sending	5	s
Energy consumption in operational amplifier	5e -10	J
E_{ini}: Initial Energy	0.006 1	J
R: mobile sink radius in meter	10,25	

Table1. Values of parameters

Table 2 shows select a subset of sensor locations adaptively for mobile sink with various radiuses to enhance network need to manage radius to sink.

Table2. Radius (R) node trajectory

nodes	Movement of R25		Movement of R15	
1-75	R 15	R 16	R 3	R 7
76-150	R 16	R 17	R 4	R 8
151-225	R 17	R 18	R 5	R 9
226-250	R 18	R 19	R 6	R 10

4.2 Performance of Remaining Energy with Mobile Sink Using Proposed Method:

Figure 4 contains two different positions for radius 10 and 25 respectively as in table 2, changes in nodes supposed to be after each 75 nodes location via overall nodes choosing of each nodes value of mobile radius sink mobility to enhance energy consumption.

Figure 4 shows the position of node after step movement towards or far from mobile sink which is used to calculate the assumed movement of nodes with random direction towards the sink node, whenever Figure 5 use equation 4 to find energy consumption after one movement.

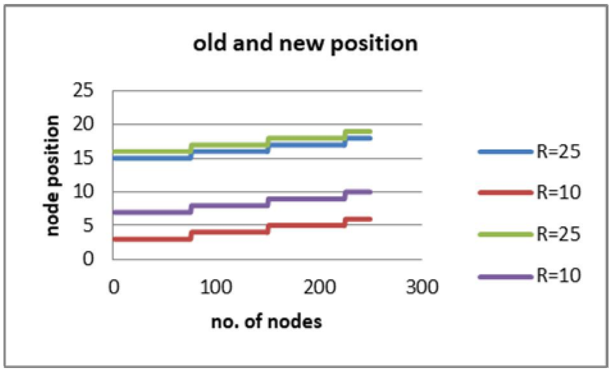

Figure 4 : Old and new position for node

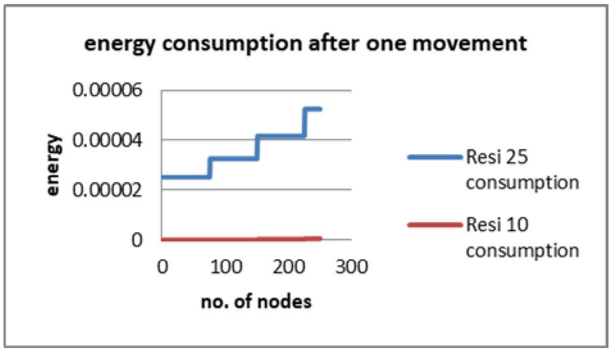

Figure 5 : Energy consumption after one movement

Better network lifetime after single hop moving through the network showed mobile sink results demonstrates travels around the sensor filed with 10 unit of distance to radiuses in Figure 6 shows the impact of movement of energy consumption in sample network below:

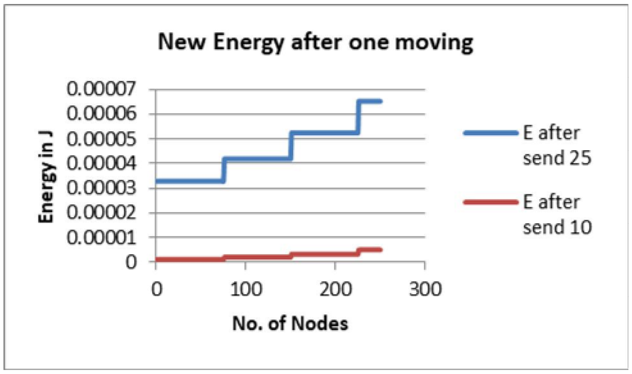

Figure 6 : New energy after one moving

Figure 7 presents authors in [35] to demonstrate the remaining energy for particular node which had been proposed and will be compared in this paper, sink keep place near lowest remaining energy node to keep network alive with specific velocity with impact of path to enhance energy consumption regarding to how much node power of previous work to compare with proposed method in this paper.

Figure 7 shows EPEGASIS "Enhancement power efficient gathering in sensor information systems", two routing protocol to increase network lifetime [35] to find optimal communication distance, it also discussed a life time of network with adjusting parameter =0.2 with maximum life time.

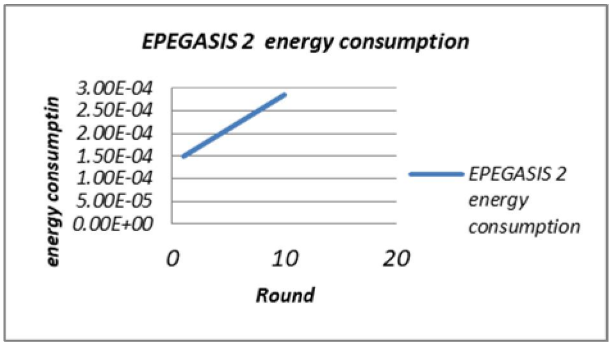

Figure 7: EPEGASIS 2 energy consumption

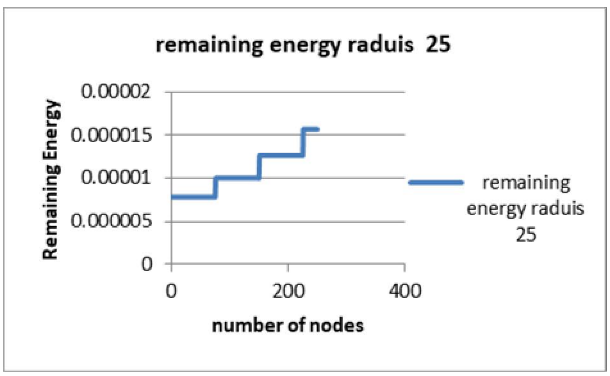

Figure 8a : Remaining energy radius 25

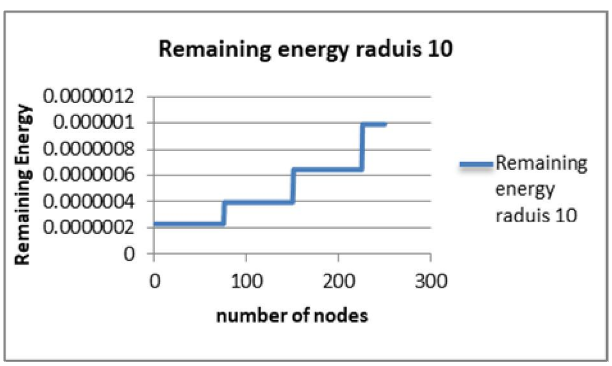

Figure 8b : Remaining energy radius 15

Figure 8 a&b shows remaining life time with constant radius for each 75 nodes, it differs for second 75 nodes and so on with different parameters for figure 7 [35] which used initial energy 0.05 J.

The effect of changing value of node location parameters on network lifetime each step by choosing selected position supposed in table 2 with selecting positions and adjusting parameter regarding to sink to find optimal position "best path" for send packet via specific route to increase network lifetime.

Energy nodes residual divided on its distance to base station.

5. CONCLUSION

In this paper, new energy efficient scheme has been presented in this work by selecting random positions with mobile sink to enhance performance of WSN with mobile sink in WSN with various conditions deceasing active area to decrease transmission time to maximize power the battery life of sensor.

Next, presenting results validate the of new proposed algorithm contribution along with enhance performance measured by number of nodes, mobile sink, and other parameters listed in table 2.

Finally, compare results with other works in [35] to show the differences of performance of proposed work.

Real sensors and mobile sink with small sample of connected network rather than simulation will give better idea especially to give exact results according to real time cases.

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