

Energy Optimization through Position Responsive Routing Protocol (PRRP) in Wireless Sensor Network

Noor Zaman and Azween B Abdullah

Abstract—Wireless Sensor Networks (WSNs) are consist of very tiny nodes structure, with very small batteries without having facility to recharge it. It works under any hard circumstances, hence this type of network is gaining high importance day by day. Maximum focus of researchers is to enhance or optimized its energy efficiency level. Routing protocol is the main energy expensive operation of sensor networks which utilize maximum energy resources of sensor network. Already a good number of routing protocols has been designed for energy efficiency or optimization with different approaches under controlled conditions. With this research we try to propose energy optimization of wireless sensor network through our proposed position response routing protocol (PRRP), under certain controlled parametric consideration. Research results shows a significant energy optimization in the life cycle of WSN.

Index Terms—WSN, energy efficient, WSN routing protocol, GPS, PRRP, energy optimization

I. INTRODUCTION

WSN is a wireless network consisting of small nodes with sensing, computation, and wireless communications capabilities [1]. Each sensor collects data from the monitored area (such as temperature, sound, vibration, pressure, motion or pollutants). Then it routs data back to the base station BS [2]. Data transmission is usually a multi-hop, from node to node toward the base station. Sensor nodes are equipped with small, often irreplaceable batteries with limited power capacity. WSN consist of hundreds or thousands of small, cheap, battery-driven, spread-out nodes bearing a wireless modem to accomplish a monitoring or control task jointly.

An important concern is the network lifetime: as nodes run out of power, the connectivity decreases and the network can finally be partitioned and become dysfunctional [3]-[5]. Routing in WSNs is a very challenging problem due to the inherent characteristics which differentiate such networks from other wireless networks such as ad hoc networks and cellular networks [6]-[7]. In recent years, many algorithms have been proposed for the routing issue in WSNs. The minimum energy routing problem has been addressed in [7]- [14]. The minimum total energy routing approaches in these papers are to minimize the total consumed energy. However, if all traffic is routed through the minimum energy path to the destination, the nodes along that path will run out of batteries quickly rending other nodes

useless due to the network partition even if they do have available energy. Instead of trying to minimize the total consumed energy on the path, the objective is to maintain the connected network as long as possible. If sensor nodes consume energy more equitably, they continue to provide connectivity for longer, and the network lifetime increases. [15]-[18].

As sensor networks have specific requirements on energy saving, data-oriented communication, and inter-connection between non-IP and IP, therefore sensor network-dedicated routing protocols may be required, for Energy optimized and efficient routing scheme.

II. PROBLEM STATEMENT AND NETWORK MODEL

Routing in WSNs have a primary task for transfer of data from source (sensor node) to the sink, in case data is available for transfer in resulting of any physical event occur or time driven query run at the sensor node. Initially routs defined by the nodes then nodes become able to send or receive the data by using those routing paths.

A. Problem Statement

An ample number of different routing protocols had been designed by the researchers, On the basis of topologies routing protocols may categories, like Flat routing Protocols, Hierarchal routing Protocols and Location based routing Protocols. Among all topologies based routing protocols, hierarchal routing protocol technique is more popular regarding the power saving of sensor nodes. This technique works on the formation of several clusters (a sub network within network). Cluster is responsible to transfer data from node to the sink, while direct data sending approach from each node is not supported with this method. Clusters communication works on the basis of cluster leader which can be known as cluster head. Communication with sink can be done with the help of cluster head; they collect data from neighboring nodes and send it to another cluster head, which is responsible for any other cluster, this mechanism continuous until the data reaches to the sink. the current energy efficient routing protocols including LEACH and HEED is also designed on the basis of clustering. The main issue with this method is cluster heads normally remain active for more time than other nodes in the cluster and resulting they lose their energy before other nodes. Another important concern is that it is hard to maintain the energy level of all sensor nodes at same level, and if cluster head loose it energy first then in that case, it is possible that we might lose one segment of network from our main network topology. Even though those routing protocols works fine up to a limited size of sensor network,

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The authors are with the Department of Computer and Information Science, Universiti of Tecknologi PETRONAS (UTP), and Malaysia (e-mail: noorzaman650@hotmail.com, azweenabdullah@petronas.com.my)

but they are not suitable for large amount of networks, as they broadcast the message to find out their neighbors and also to form new clusters by finding new cluster heads. In this process they lose an ample amount of energy, and even assumptions which they made or not possible normally in real, such as LEACH assumes that all nodes are homogenous and equal in power while it is not in actual.

Hence it is highly needed to design an energy efficient routing protocol with assumptions closer to the real, we are proposing position responsive routing protocol (PRRP) with the help of global positioning system (GPS) which is more energy optimized and efficient than the existing protocols. In this approach nodes and cluster heads will be informed about their position through GPS.

B. Network Model

Our assumptions for sensor network is such as that, sensor nodes are randomly distributed over an area of 90 x 90 meters with following network properties.

- 1) Network is static and nodes are distributed in random format, while area is divided in equal square grid format.
- 2) There is exists only one base station, which is deployed at a fixed place outside.
- 3) The energy of sensor nodes cannot be recharged.
- 4) Sensor nodes are position responsive, through GPS.
- 5) The radio power can be controlled, i.e., a node can vary its transmission power.

Above all assumption are on wide scope, assumption no. 5, is becoming the cause of energy saving, as nodes will be aware about their location and sink too, hence the amount of energy which normally network always use to find out the initial location will be saved.

III. SCENARIOS AND TOPOLOGIES

The entire simulation tests were conducted by using a very well known simulator by the research community NS2, by applying various topologies. The few are shown in Fig. 1. tested routing capabilities in two ways, initially it was tested with a normal approach, while in second phase it was tested through PRRP Algorithm, in which each node was aware about its neighbors' location through GPS. The second routing approach gave excellent results in terms of it energy optimization or power saving. We will discuss those result with coming sections with the help of figures.

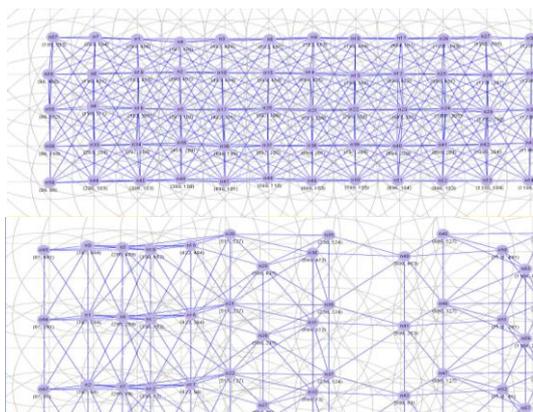


Fig. 1. Different WSN topologies

IV. SIMULATION

Simulations has been done with the help of worldwide well known and acceptable NS2 simulator, NS2 is an object-oriented, discrete event driven network simulator developed at UC Berkely written in C++ and OTcl (Tcl script language with Object-oriented extensions). It implements network protocols such as TCP and UDP, traffic source behavior such as FTP, Telnet, Web, CBR and VBR, router queue management mechanism such as Drop Tail, RED and CBQ, routing algorithms such as Dijkstra, and more. NS also implements multicasting and some of the MAC layer protocols for LAN simulations.

NS-2 includes a tool for viewing the simulation results, called NAM. NAM is a Tcl/TK based animation tool for viewing network simulation traces and real world packet trace data. Through its user interface, NAM provides control over many aspects of animation. This simulation tool has worldwide acceptability with very high acceptance rate of result.

A. Simulation Parameters

Standard Simulation parameters are shown in Fig. 2. below.

Channel type	Channel/WirelessChannel
Propagation model	Propagation/TwoRayGround
Phy type	Phy/WirelessPhy
Mac protocol type	Mac/802_11
Queue type	Queue/DropTail/PriQueue
Link layer type	LL
Antenna type	Antenna/OmniAntenna
Max packet in queue	50
Routing protocol	DSDV
Agent trace	ON
Router trace	ON
Mac trace	ON
Movement trace	ON
Gt_	1
Gr_	1
L_	1.0
freq_	2.472e9
bandwidth_	11 Mb
Pt_	0.031622777
CPTresh_	10.0
CSTresh_	5.011872e-12
RXThresh_	5.82587e-09
dataRate_	11 Mb
basicRate_	1 Mb

Fig. 2. Simulation parameters.

As mentioned earlier, the entire simulations were done using NS2 simulator, screenshot of the NS2, NAM during simulation shown in Fig. 3. NAM is a graphical interface in which simulation controlling events are available during the active session of wireless simulation.

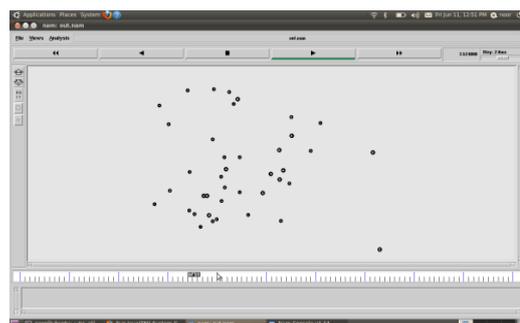


Fig. 3. Screen shot of NS2 NAM

B. Results with Figures

1) WSN Nodes before PRRP approach

Simulation results before applying PRRP approach, is shown in figures ranging from 1 to 3, after repeating hopes. Those are actually plotted between two parameter such as, Fig. 1 X-axis is for time while Y-axis for cumulative energy level for sensor nodes. Three different cases were taken in account with initial assumption that nodes are not position responsive, and they are scattered in random fashion over an area of 90 x 90 meter. Case one Fig. 1, is showing the comparison between time and energy level for routing, while with second case in Fig. 2, showing the comparison between time and energy level after a number of hopes. With third case in Fig. 3, is showing the comparison for routing data. All results are showing clear understanding about routing data and sensor nodes energy. Fig. 1 shows that almost 50 nodes or 100% nodes are alive when the process started, while all nodes drain their energy almost after 38 second of active routing operation.

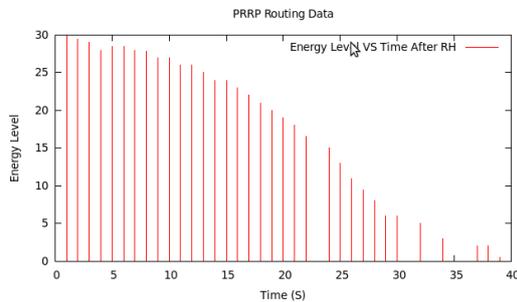


Fig. 1. WSN energy drain after repeating hopes.

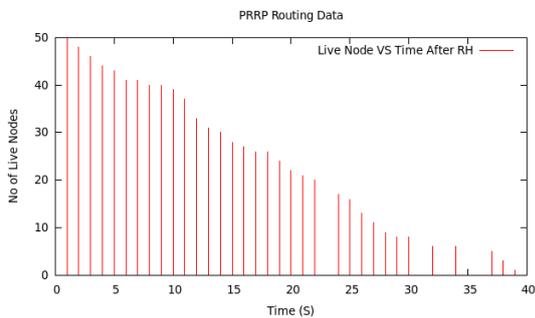


Fig. 2. WSN nodes life VS time after repeating hopes

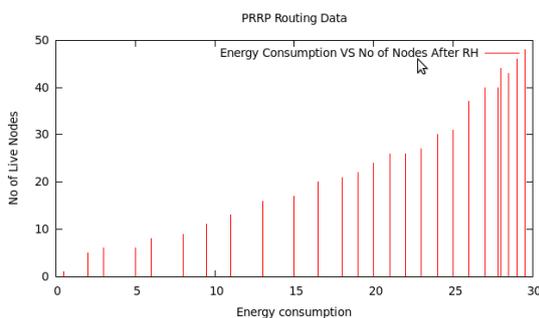


Fig. 3. Number of hopes VS energy consumption:

Fig. 4 shows the result for entire energy loss process for all hopes simultaneously with the help of different colors, it shows that during the initial hopes the energy level of the nodes were sufficient enough and it was shown with blue color. However when the numbers of hopes were increased the energy level also drastically goes down as shown with different colors which were indicated in light blue, then yellow and finally towards red, which is the last level of energy and at that level almost all energy of node were

drained completely.

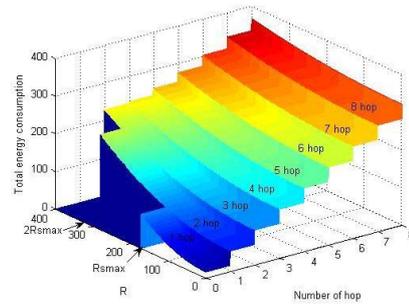


Fig. 4. Number of hopes VS energy consumption

2) WSN Nodes after PRRP approach

Figures ranging from 5 to 7 is actually again plotted between two parameter same parameters, but after applying PRRP routing approach with it. Again three different cases were taken in account with assumption that nodes position responsive and they are aware about their position through GPS, and are scattered in random fashion over an area of 90 x 90 meter. As all cases are taken in account as same as before but only the difference is of PRRP approach now. Results with the help of us shows clear understanding about energy optimization and efficiency of sensor networks. The result shown in the Figures ranges from 5 to 7, is totally different than the figures ranges from 1 to 3, as at this stage we consider the position responsive routing protocol algorithm in which we consider that all the neighbor nodes are already aware about their neighbor nodes position through GPS. By applying this protocol each node save his initial energy, as there is no need to broadcast or send request to send RTC, initial data packets to the neighbor to find out the sink. In this way nodes life enhanced approximately from 38 seconds to almost 52 seconds and during this life enhancement period the network also enable to work for more data transfer and remain live for more time period, optimization of sensor network becomes high. PRRP routing approach increases the time span of sensor network operation which enhances network optimization and efficiency.

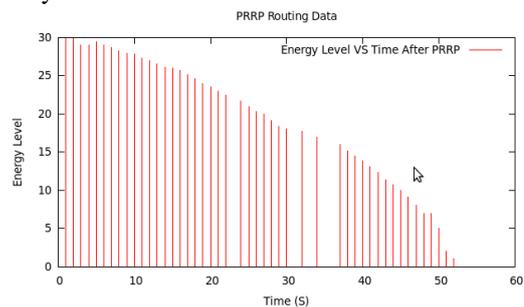


Fig. 5. PRRP WSN nodes energy drain after repeating hopes

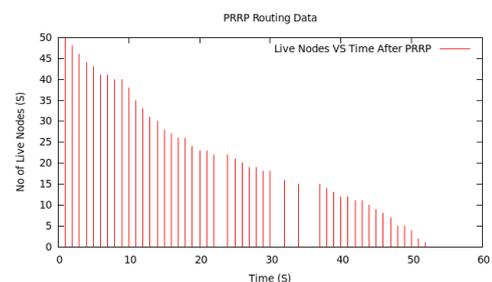


Fig. 6. PRRP WSN nodes life with time after repeating hopes

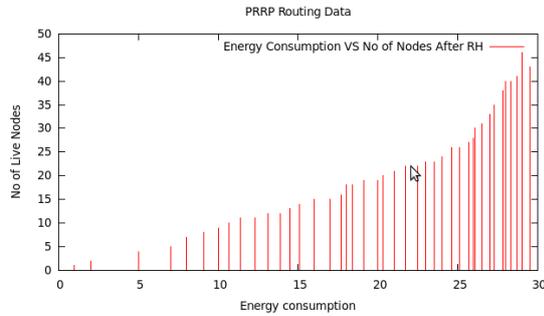


Fig. 7. PRRP generally energy consumption for all nodes

V. CONCLUSION

Wireless sensor network becomes more attractive area for the researchers nowadays, due to the wide range of its application areas, and distributed nature of its deployment in remote areas. Energy is the prime concerned for such type of networks, routing is the most expensive operation for node energy consumption. Our proposed Global Positioning System (GPS) based Position Responsive Routing Protocol (PRRP) enhances and optimized sensor networks energy level. Results are confirming energy optimization level of wireless sensor networks through our proposed routing protocol approach.

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Noor Zaman acquired his Degree in Engineering in 1998, and Master's in Computer Science at the University of Agriculture in Faisalabad in 2000. His academic achievements further extended with a PhD in Information Technology at UTP, University Technology PETRONAS Malaysia. He is currently working as a Faculty member in the College of Computer Science and IT, King Faisal University, in Saudi Arabia. He takes care of versatile operations including teaching, research activities, Information Technology management, and leading ERP projects. He headed the Department of IT, and administered the prometric center in the Institute of Business and Technology (BIZTEK), in Karachi Pakistan. He has worked as a consultant for Network and Server Management remotely in Apex Canada, a USA based Software house, and call center. Noor Zaman has authored more than 40 research papers, and edited four books, has many publications to his credit. He is an Associate, Regional Editor and reviewer for reputed international research journals around the world. He has completed several research grants and currently involved with funded projects in different courtiers. His areas of interest include wireless sensor network (WSN), networks, artificial intelligence, telecommunication, mobile computing, software engineering, Unix, and Linux.



Azween Abdullah obtained his Bachelor's degree in Computer Science in 1985, Master in Software Engineering in 1999, and his PhD in Computer Science in 2003. His work experience includes twenty years in institutions of higher learning and as a director of research and academic affairs at two institutions of higher learning. Dean of his faculty, and fifteen years in commercial companies as Software Developer and Engineer, Systems Analyst, and IT/MIS and educational consultancy and training. He is currently an Associate Professor at Universiti Teknologi PETRONAS, Malaysia. He spent more than a decade with leading technology firms and universities as a process analyst, senior systems analyst, and project manager. He has participated in and managed several software development projects, including management Information Systems, software process improvement initiatives design and implementation, and several business application projects. He has many years of experience in the application of IT in business, engineering, and research and has personally designed and developed a variety of computer software systems, including business accounting systems, software for investment analysis, website traffic analysis, determination of hydrodynamic interaction of ships, and computation of environmental loads on offshore structures. His area of research specialization includes computational biology, system survivability and security, autonomic computing, self-healing and regenerating systems, formal specifications, and network modeling. His contributions include publishing several academic books and in the development of programs to enhance minority involvement in bridging the ICT digital gap.