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Energy Preservation through Rest Planning Algorithm for Wireless Sensor Networks

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Abstract: Wireless Sensor Networks applications often need to be changed after deployment for a variety of reasons. Reconfiguring a set of parameters and patching security holes and modifying tasks of individual nodes. Wireless reprogramming is a crucial technique to address such challenges. Code Dissemination is a basic building block to enable wireless reprogramming. We present a link quality aware Sleep Scheduling Algorithm leveraging the 1-hop link quality information. It has following salient features compared to prior works. First, it supports dynamically configurable packet sizes. Second, it employs an accurate sender selection procedure to mitigate transmission collisions and transmission over poor links. Third, it conserves energy and also takes short completion time.

Keywords: Wireless Sensor Networks; Dissemination; Reprogramming

I. INTRODUCTION

A Wireless Sensor Network (WSN) is a distributed network and it comprises a large number of distributed, self-directed, and tiny, low powered devices called sensor nodes alias motes. Sensors are used to monitor specific environmental and physical events or phenomena. Military purposes are the first factor to motivate the earlier development of WSN in order to do the battlefield surveillance which is a process of systematic observation of people and places by visual, electronic or some other means. The new technologies have reduced the cost, size, and power of these sensor nodes making the wireless sensor networks an interesting topic in the field of wireless communication. Now a day's wireless network is the most popular services utilized in industrial and commercial applications, because of its technological advancement in the processor, communication, and usage of low power embedded computing devices. Sensor nodes are used to monitor environmental conditions like temperature, pressure, humidity, sound, vibration, position etc. In many real time applications, the sensor nodes are performing different tasks like neighbor node discovery, smart sensing, data storage and processing, data aggregation, target tracking, control and monitoring, node localization, synchronization and efficient routing between nodes and base station.

Reprogramming is a critical issue in remote sensor systems. It is the ability to change programming usefulness of nodes inside the system at run time. It empowers clients to increase or adjust usefulness of a sensor network after arrangement, with a low price. Changes come as updates, comprising of new applications, bugs, and modified parameters. Remote sensor nodes are normally reconstructed in two ways: either by flashing the node with an entire firmware picture or by loading a fractional executable parallel. Reconstructing is essential both for improvement, and for quick prototyping and troubleshooting, and after sending, for adjusting functionality.

Due to their limited power and short range, sensor nodes need to collaboratively work in multi-hop wireless communication architectures to allow the transmission of their sensed and collected data to the nearest base station. So the sleep wake schedule becomes an important and effective mechanism to maximize the lifetime of sensor networks. When there are no events the nodes can be put to sleep so that energy consumption by sensor nodes can be significantly reduced. Mobile ad hoc network is an active network formed by a great number of nodes. Furthermore, the nodes are dependent on the limited battery power. Power scarcity in any node may result in network breakage. Routing is the key functionality for directing communication over large networks. The primary task of any routing protocol is to find and maintain routes to arrive at the destinations.

II. LITERATURE SURVEY

Wei Dong et al., [1] has worked on the code dissemination protocols and developed an Efficient Code Dissemination (ECD) protocol based on the TinyOS platform. ECD has the following features. It configures packet sizes dynamically. It makes use of a precise algorithm to select sender in order to avoid broadcast collisions and transmission over bad links. It makes use of a backoff timer design to reduce the total time spent in coordinating the multiple eligible senders. Its performance is evaluated through simulations and test bed experiments. The outcome shows that ECD performs better than Deluge and MNP.

W. Dong et al., [2] proposed a method to mathematically analyze the performance of data broadcasting protocols in wireless sensor networks. Here author validated the analytical results from simulation. The author also has shown that by using analytical results in protocol design the performance optimizations can be achieved.

Milosh Stolikj et al., [3] has worked on reprogramming of wireless sensor networks and identified these two problems they are improving the energy efficiency and improving the hold-up time in reprogramming. All algorithms were ported to the Contiki embedded operating system and profiled for diverse types of reprogramming. Results showed that at hand is a clear trade-off between performance and resource requirements.

J.W. Hui et al., [4] proposed Deluge protocol for transmitting large code objects from source nodes to other nodes through a multi-hop WSN. And author showed by using both simulation and real world deployment that Deluge can consistently send data to all nodes. The outcome showed that Deluge can push nearly 90 bytes per second.

Subhash Dhar et al., [5] proposed a unique method for scheduling sleep to sensor nodes by means of an energy competent routing protocol and a tree. The tree is occasionally reconstructed by taking into account the left over energy of every node in order to balance the amount of energy utilization by nodes plus to remove nodes that are failed.

S. Kulkarni and L. Wang et al., [6] proposed MNP protocol which uses an algorithm to select sender which tries to make sure that in locality there is at max one node which is sending the program to other nodes at this time. In MNP based on the requests received by source nodes, they compete with each other. Here in the sender selection process sender with the highest impact is selected.

Wei. Dong, Xue Lui et al., [7] have worked on a Dynamic Packet Length Control (DPLC) scheme. They incorporated an accurate method to estimate link which captures both physical channel interferences and conditions to make the DPLC scheme efficient in terms of utilization of channel. The implementation of DPLC scheme is considered lightweight with respect to memory, header overhead, and computation.

S. Murthy et al., [8] has worked on the protocol called Wireless Routing Protocol (WRP). In this, for each destination, the distance and the second to last hop distance is transferred by routing nodes. In WRP the cases in which a momentary routing loop can take place is reduced. The simulation results showed that WRP is mainly efficient protocol.

E. M. Royer et al., [9] author has worked on direction finding protocol for ad hoc mobile wireless network. Finding proficient and correct route between nodes is the most important goal of an ad hoc routing protocol in order to transport messages in an appropriate manner. In this article different protocols are evaluated on some known set of parameters.

W. R. Heinzelman et al., [10] here author proposed Low Energy Adaptive Clustering Hierarchy (LEACH) protocol which is depending on clustering. This protocol enables robustness and scalability for dynamic networks by using localized coordination and reduces the quantity of information being sent to the base node by data fusion. Simulation result showed that LEACH can attain 8% reductions in energy dissipation in comparison with existing protocols.

R. Shah and J. Rabaey et al., [13] have proposed a method called energy conscious routing which use the suboptimal path to give the extensive gain. Simulation outcome showed with the intention network lifetime can be increased up to 40% compared to scheme like directed diffusion routing.

X. Hou and D. Tipper et al., [14] have proposed a protocol called Gossip-based Sleep Protocol (GSP) which is a flat structure based. In GSP nodes are made to sleep with gossip sleep probability p for some time randomly. The network remains connected until the cost of p is small enough. The author proposed two separate version of GSP and showed advantages that can be achieved by using GSP approach from simulations.

III. MATHEMATICAL MODEL

In wireless sensor network for packet transmission from one node to another node efficient path has to be selected with minimum cost. One factor contributing to the selection of efficient path is the distance between nodes. So the distance between nodes is calculated by using Euclidian distance equation.

$$\text{Distance Equation } d = \sqrt{(X1 - X2)^2 + (Y1 - Y2)^2} \quad (1)$$

where X and Y represent a point coordinates.

Link quality is the main factor contributing to the selection of the efficient path. So if the link quality is good then high throughput can be achieved by avoiding transmissions getting collided and transmission over links that are poor. It also leads to short completion time. Link quality is analyzed based on the following metrics:

- Distance between nodes
- Energy in each node
- Packet reception ratio of each node

IV. PROPOSED SYSTEM

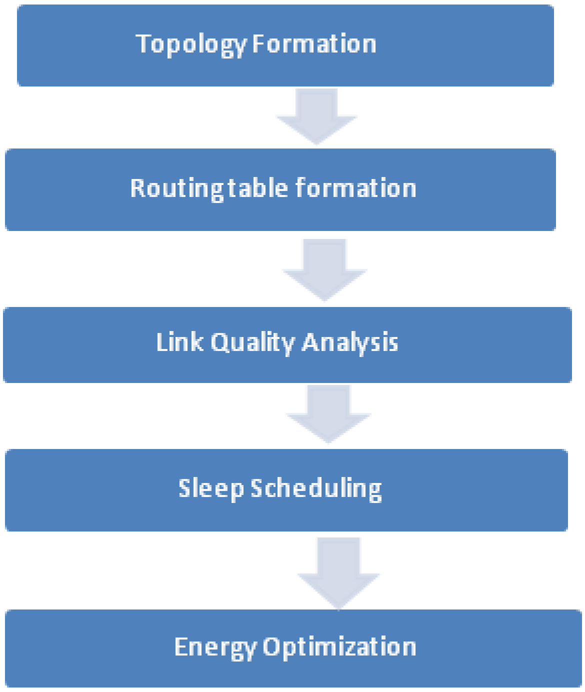

Fig. 1 Proposed System Architecture

The proposed system aims at finding link quality of each link connecting different nodes and selecting best pathway from one node to another node to avoid broadcast over links that are poor.

Link breaks are automatically updated. This can be used in code dissemination process to complete the process in short time. To enable code dissemination small piece of code is encrypted and decrypted. And also sleep scheduling algorithm is incorporated to save the energy consumption in a wireless sensor network to maximize lifetime of network and to maximize the throughput of the network.

A. System Architecture

As shown in the above figure the proposed system consists of five phases. They are as follows.

a. Topology Formation

This module involves building Wireless Network topology, topology consisting of mobile nodes, each node working with multiple channels. This module consists of following steps such as setting up wireless network topology, specifying the simulation start time and end time, specifying the source, destination and data, identifying the neighbors, setting up OLSR parameters, setting the bandwidth and threshold.

b. Routing Table Formation

In this phase with the help of distance equation, the distance between nodes is calculated and 1- hop distance routing table is formed for each node. This information is used by OLSR in the next phase.

c. Link Quality Analysis

In this phase OLSR uses the routing information and the link quality of each node and calculates the efficient routes between each nodes so as to reach the destination node as early as possible in order to take short completion time and if there is failure of any link it also calculates new route through another link and updates the corresponding routing table.

d. Sleep Scheduling

In this phase Connected Dominating Set (CDS) construction takes place. It is a prerequisite step for sleep schedules. It first constructs connected dominating set for parent selection and uses sleep schedule scheme. sleep scheduling algorithm is used. In sleep scheduling algorithms most of the nodes are put to sleep to conserve energy and increase network life time. The main purpose of any sleep scheduling algorithm is to maintain network connectivity. Here an energy aware routing protocol is integrated with the proposed sleep scheduling scheme.

e. Energy Conservation

The proposed approach also considerably reduces average energy consumption rate of each node as we are able to put more number of nodes to sleep in comparison to other approaches such as GSP, which incorporates sleep scheduling using random approach. In this phase, we can see the amount of energy conserved.

V. SIMULATION RESULTS

Below figure shows the simulation results of the network topology of 50 nodes. The proposed energy efficient algorithm is implemented in NS2.When simulation begins user can see the result as shown below. Figure 2 shows for each node the status of links that are connecting to other nodes. It also displays neighbor nodes distances and whether the link connecting to that neighbor is symmetric or asymmetric. Symmetric links are considered to be good for further packet transmission whereas asymmetric links need to be removed and updated. It also shows links that are broken. After detection of link breaks, such links are removed immediately from the nodes that are connecting to other nodes via these links. And also alternate path is selected for such nodes and the routing table is updated with new route with good link qualities. Updated links are selected based on the distance between nodes and energy remaining in the node. So that packet will be sent over good links. By doing so completion time is also reduced. And at the same time, the nodes that are not involved in the transmission are put to sleep so as to conserve energy remarkably.

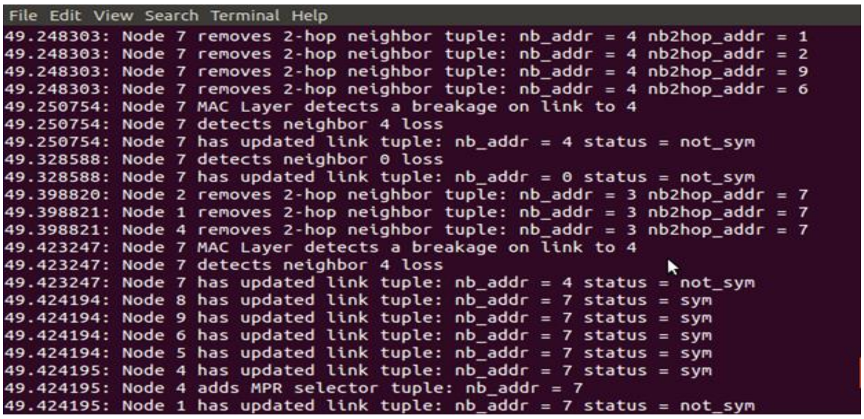

Fig. 2 Link Breaks and Updates to the Routing Table with Status

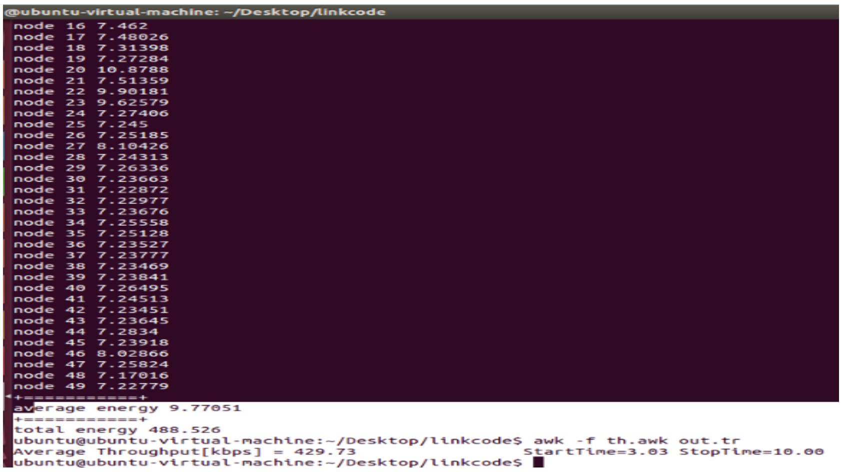

Fig. 3 Energy Consumption without Sleep Scheduling of Nodes

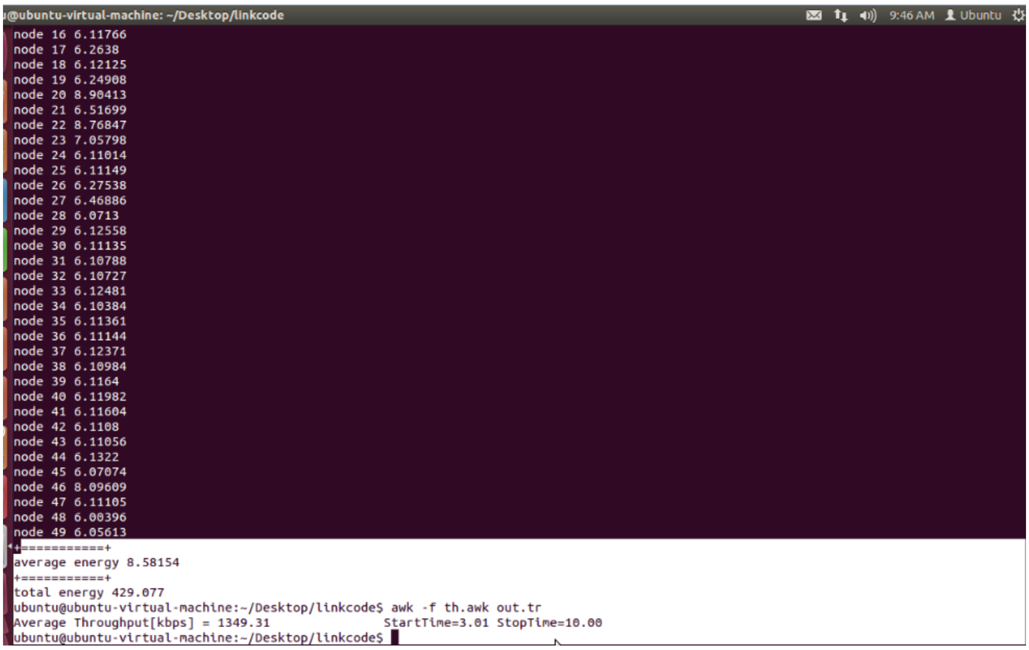

Fig. 4 Energy Consumption with Sleep Scheduling of Nodes

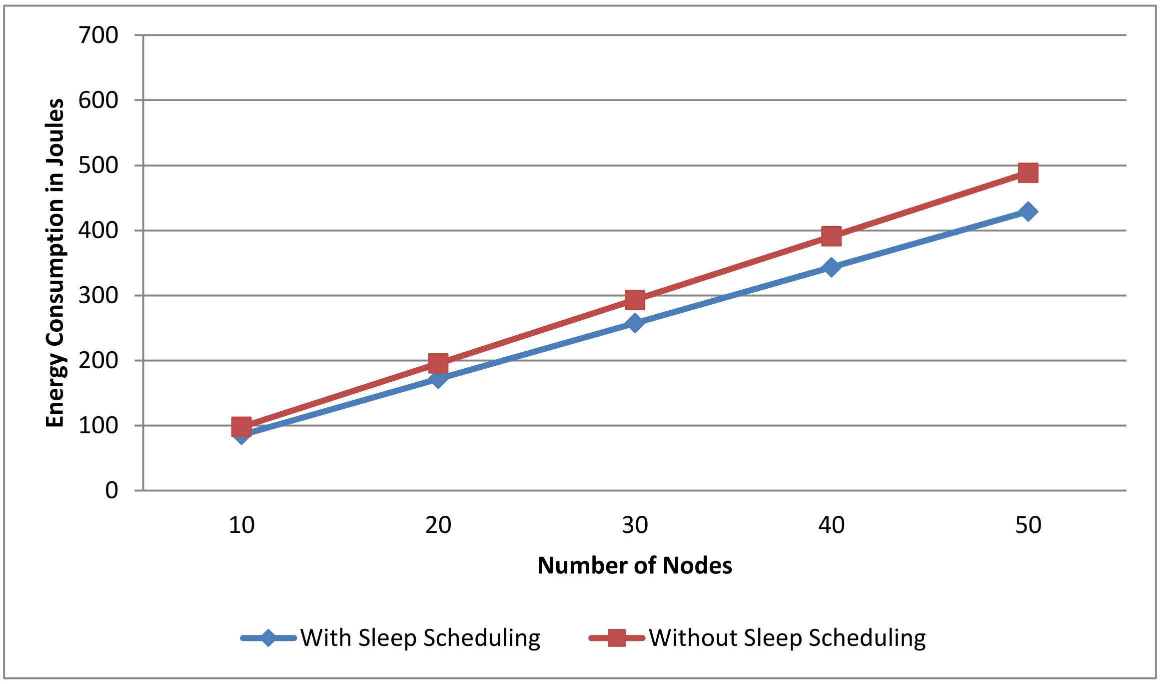

Fig. 5 Performance Graph

With simulation results performance of the proposed algorithm is analyzed by comparing the metrics such as energy consumption and throughput.

CONCLUSION AND FUTURE WORK

Wireless Sensor Networks applications need to change after their deployment for reasons such as reconfiguring parameters and patching security holes and modifying tasks of individual nodes so conserving energy is important. Here proposed link quality aware sleep scheduling algorithm leveraging the 1-hop link quality information is implemented in NS-2. It has the following features. First, it makes use of the link quality information for route selection to avoid transmission over the links that are poor. Second, it conserves energy by making use of sleep scheduling and also takes short completion time. Simulation results show that it makes use of link quality information effectively to detect link breaks and also updates such links with the alternative path. We can also observe that it also does energy conservation remarkably. In future effectiveness of this design can be examined in large scale wireless sensor networks systems in real time.

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