Energy Efficient Algorithm for Congestion Control in Wireless Sensor Networks

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Abstract –In recent years, wireless sensor networks have been applied into real time application such as environment monitoring, health monitoring and military etc. The data in these applications are considered as critical. Hence, reliability of communication is crucial since real-time data must meet the deadline given for data transmission. To ensure the reliability in wireless sensor networks applications, power efficiency needs to be focused since sensor nodes have a limited power supply. As usage of wireless sensor network is rapidly increasing, the power efficiency in wireless sensor networks is a main factor to ensure the success of the technology.

A substantial part of the energy of the nodes is consumed in routing process and initialization process in routing mechanism, what applies a significant impact on energy performance level. Most protocols examined energy level and performance in terms of the entire process of routing mechanism. Wireless Sensor Networks have growing applications with the growth of technology. Hence the density of the WSN nodes is also becoming high resulting in congestion over the network. Effect of congestion is causing adverse effects over the WSN not only in respect of the performance but energy of the nodes is consumed quickly for non productive work. Therefore reducing the congestion in WSN will increase energy efficiency as well. This work proposes a communication algorithm for WSN networks so that the congestion will be reduced and in turn energy will be utilized efficiently.

Keywords: Wireless Sensor Networks, Store & Forward Technique, Power & Energy Levels,

I. INTRODUCTION

A wireless sensor networks (WSNs) is a formation of number of nodes (even hundred of it) that communicates with each other to perform sensing process. Normally each node equipped with a battery to power it up, a main board with a chip and memory that acts as a CPU for the nodes. Each node has sensing capabilities to sense the environment information (temperature, earthquake and etc) and process the information to be send through the network. Nodes can be hundred (even thousand of it) and each of the nodes connects each other to form a network communication. All the nodes will monitor and controlled by a base station or sink which is responsible to receive all information sensed by the nodes. In recent years, wireless sensor networks have been applied into real time application such as environment monitoring, health monitoring and military where the data in these application is considered as critical. Hence, reliability communication is crucial since real-time data must meet the deadline given for data transmission. To ensure the reliability in wireless sensor networks application, power efficiency needs to be focus since sensor nodes has a limitation in power supply. As usage of wireless sensor networks application is rapidly grows, the power efficiency in wireless sensor networks is a main factor to ensure the success of the technology. Therefore, power efficient in wireless sensor networks is a critical part and in recent years, this part has been focus by researchers to improve the efficiency in power usage.

Routing protocol mechanism can contribute high power consumption if the routing algorithm doesn't have power management capabilities. In multihop wireless sensor networks, the intermediate nodes responsible to relay packet from the source to its destination based on the routing tables which list all nearest neighbour node available. Thus, routing protocol requires an efficient way to manage the route path based on the routing table in sensor nodes. In recent years, most energy efficient routing are usually using lowest energy path consume at a node to use as a route selection based on the routing table information. According to the researchers, an obstacles need to be solve to have a successful wireless sensor networks application in the future which is energy limitations, computation power and communication resources. These obstacles relates with one problem;

ISSN 2229-5518

energy. Each of the elements mentioned by them has shown that energy is one of the most important factors in wireless sensor network environment. The comprehensive studies on current problem of wireless sensor networks energy constraint are further described in.

II. Existing System

Wireless sensor network (WSN) is a technology which consists of a number of sensor nodes distributed among of an area usually for monitoring purposes. As the emerging of this technology has been rapidly increased nowadays, the successful of the wireless sensor networks application is highly depends on the reliable communication among the sensor nodes. One major problem in wireless sensor networks environment is the limitation of the physical resource in sensor nodes which energy resource has been identified as a critical constraint for achieving the demanding capabilities in wireless sensor networks application. Packet dissemination is one of the data transmission methods in wireless sensor networks routing protocol where it would cause high energy consumption in sensor node due to the high energy consuming for disseminate the packet through the network. Initial step in routing protocol using packet dissemination method for wireless sensor networks could contribute energy efficiency if it has the ability to reduce the energy consumption. The proposed store-forward technique is to define the initial step in packet dissemination routing protocol whereas to identify the neighbor nodes without consuming high energy in sensor nodes. The result shows using the store-forward technique gave significant impact in conserving the energy in sensor nodes where it slightly reduce the energy consumption in terms of power availability after the routing initialization process is executed[1].

The future wireless systems are being designed for extremely high data rates and are directly contributing to the global energy consumption. This trend is undesirable not only due to the environmental concerns, but cost as wells energy costs are becoming a significant part of the operating expenditures for the telecom operators. Recently, energy efficient wireless systems have become a new research paradigm. Cooperative communication has shown good potential in improving coverage, providing robust radio links, reducing infrastructure cost, and has the possibility to reduce the total system energy consumption. This paper looks at possible deployment strategies for wireless networks that can reduce the energy consumption. We look at the tradeoff between the number of relay nodes and the number of base stations and their implications on the total energy consumption of wireless networks. The obtained results show that adaptive resource allocation between the base station and the relay node is an efficient way of reducing the energy consumption of the system. Furthermore, this reduction in energy consumption increases with increasing the system target spectral efficiency [2].

It also elaborates as Energy consumption is a main research issue in wireless sensor networks; and particularly in those where nodes collaborate to reach a goal. This article explores the energy consumption in mobile devices participating in a human-based wireless sensor network. Specifically, the paper proposes the use of a message predictor to help detect and reduce the number of unnecessary control packets delivered by the nodes as a way to keep updated the network topology. In order to evaluate this proposal, the Optimized Link State Routing protocol was modified to add a message predictor between the routing and the network layers. Eleven simulations were performed using a particular setting. The preliminary results indicate the use of the message predictor can help reduce considerably the nodes energy consumption without affecting the routing capability of the protocol. Although these results are still preliminary, they are highly encouraging [3].

A grid-based routing protocol which divides the network area for large side length of square cells by using cell rotation to reduce the number of relay nodes between the source node and the mobile sink. The proposed scheme divides each cell into multiple sub-cells, and assumes one or two sub-cells to be active-cells. Then, the proposed scheme confines the existing area of active nodes to each active-cell. Because the maximum transmission range is a fixed value, the side length of square cells can be enlarged by confining the area where the active node exists in each cell. Therefore, the proposed scheme decreases the number of relay nodes between the source node and the mobile sink due to the large cells divided, and reduces the data packets delivery

ISSN 2229-5518

latency and the energy consumption. The simulation results show that the proposed scheme improves the packets latency and the energy consumption efficiency [4].

Energy efficiency in wireless communications is one of important research issues. Previous studies on reducing the energy consumption of IEEE 802.11 WLAN systems mainly focused on the energy consumption of a single-link transmission only. However, due to its carrier sensing property, all the WLAN stations in the network receive the transmitted frames. Hence, this single-link transmission not only consumes the energy of the transmitter and receiver of the link, but also consumes the energy of the other stations. Moreover, most of the previous works on energy efficiency optimization problems were considered in MAC perspectives. In this paper, we show that the energy efficiency of all the stations in WLAN network can be optimized by our proposed adaptive transmission power control and rate selection scheme, with more accurate analysis of the energy consumption in IEEE 802.11 MAC and IEEE 802.11n PHY. The proposed adaptive transmission power control and rate selection scheme achieves an increase in an average energy efficiency of 34% at the cost of 5% throughput degradation for 800bits payload size and 20 users, for varying the distance from 0m to 90m [5].

Wireless Sensor Networks (WSNs) consist of small nodes with sensing, computation and wireless communications capabilities. Evolution in wireless sensor network has broadened its pervasive and unbiquitous applications in numerous fields. These applications often require accurate information collecting as well as uninterrupted, prolonged active service. Routing protocols have significant impact on the overall energy consumption of sensor networks.

Suitable Energy-efficient routing algorithms are required to the inherent characteristics of these types of networks are needed. Due to resource limitations in wireless sensor networks, prolonging the network lifetime has been of a great interest. Most of the energy of sensor nodes is utilized for transmission of data to the base station. Thus, it makes them to deplete their energy much faster. In this paper, Centrallty based Cluster approach is used along with a movable base station to reduce the energy consumption of cluster heads. According to the simulation results, the proposed scheme has proved its efficiency in the network lifetime, residual energy of network. The proposed scheme also shows improvement in performance of WSN compared to other routing scheme [6].

As in traditional networks, link-level retransmission based on Automatic Repeat reQuest (ARQ) has also been widely applied for the sensor network [3,4]. It points out drawbacks in this mechanism, and proposes to use one class of the FEC techniques called erasure coding, which attempts to encode error recovery information into packets to compensate for the effect of lossy links. The receiver node can reconstruct z original data packets by receiving any z out of y encoded packets. However, it requires a pre-knowledge of the channel conditions for a proper data redundancy setting, i.e., y/z.While the above two approaches are quite useful, the energy efficiency of them could be considerably affected by unreliable links .To solve this problem, there have been attempts to explore the cooperative communication technique to improve energy-efficiency for data transmission. We refer to REPF[10], ExOR[7], MRD[11], and CoopMAC[12] as the typical earlier works on this topic. However, they are designed for traditional wireless networks (e.g., MANET), and cannot be directly used due to the unique challenges of sensor networks.

Some recent studies on cooperative communication have considered the specific properties of wireless sensor networks. S.Biswas studied and compared the energy efficiency of cooperative communication and direct transmission schemes in sensor networks, without giving practical implement details for node cooperation. SPaC[14] allows nodes to buffer overheard corrupted packets and recover the original packet by combining multiple corrupt copies. SPaC inevitably increases the demand for storage space and computation overhead of sensor nodes. Cao et al, a "best" relay is selected based on RTS-CTS signaling from nodes that are neighbors of both the sender and the receiver. Then the relay node will forward the overheard data packet to the receiver separately.

ISSN 2229-5518

The receiver combines the received signal from the sender and the relay for joint decoding. It is obvious that this approach is not efficient for packet recovery, because cooperation is only needed when the receiver fails to decode signal from the sender. A similar idea on cooperative MAC (COMAC) has also been proposed by Wang et al, which requires nodes with 802.11g radios. In CBF [9], each intermediate sensor node is able to organize qualified neighboring nodes into a cluster, and a suitable helper node out of potential candidates in the cluster can take the relay responsibility if the original receiver fails. Although not been discussed in [9], the overhead incurred by cluster management cannot be simply neglected in CBF. Apart from higher layer protocols discussed above, there are also some works focusing on node cooperation at physical layer for constructing “virtual” multiple-input multiple-output (MIMO) systems .

Shakkottai et al, addressed the issue of cross layer networking, where the physical and MAC layer knowledge of the wireless medium is shared with higher layers, in order to provide efficient methods of allocating network resources and applications over the internet. Gatzians et al.,addressed the maximization of lifetime of a WSNs. The sub-gradient method is presented to minimize the required time to route data from other nodes of the network to a mobile sinks. This system is restricted to semi-deterministic settings resulting in considerable delay. Madan et al.,formulated a distributed algorithm to compute an optimal routing scheme to maximize the lifetime of network. They have not considered asynchronous sub-gradient algorithm. Laura et al., have experimented the measurement of an IEEE 802.11 wireless network interface to operate in an Ad Hoc Networks. Linear equations are used to calculate the energy consumption for sending, receiving and discarding packets of various sizes.

In the linear model the correlation coefficient is 0.99 in in every instance and uncertainty of the packets is 7% and energy conservation is about 150% in an Adhoc Networks. Energy consumption is calculated with respect to the following conditions distance, speed, cluster based routing protocols. Processing Quality is not considered for the energy consumption. Ahmed K. et al., proposed distributed relay assignment protocol for cooperative communication in wireless Networks. The relay is selected from the nearest neighbor list. The simulation results showed that, significant increment in gain of the coverage area for the cooperative routing than the direct routing. Framework for mobile sink is considered in [6] and [7]. Since the sink is mobile in nature it reduces the distance between sources and sinks and delay for transmission. In our previous work Zamath et al., we developed a mathematical model for wireless sensor networks with a single static and mobile sink to maximize energy conservation.

Wireless Sensor Networks (WSN) have wide applications in defense, environmental monitoring like temperature, pressure, vibration, moisture, industrial monitoring, medical monitoring, habitat surveillance etc. The application of WSN consists of small sensor nodes that are low-cost, low power and multi-functional. The most important task of WSN is to send the collected data to the sink node and minimize the energy consumed during data transport. Usually the sensors used in the networks are energy limited and many energy constraints like uncertainties, unreliable wireless link, node failure, dynamic traffic load are present. So for any application it is necessary to consider the node constraints.

The performance of Wireless Sensor Network is affected mainly by the uncertainty present in the environment. There are various sources of uncertainty that may affect the sensor network's operation in the real time applications. The uncertainty may due to distance between the nodes, communication channel etc. Apart from minimizing energy consumption, another problem is maximizing the data extracted to the sink node. This paper proposes an optimization of distance uncertainty for maximizing the data extraction problem. Genetic Algorithm is used to optimize this problem. The actual position of the node may differ from what sensor network planned to detect or the rate of energy consumption may deviate from the expected value. this optimization model, the aim to route data to maximize the information that reaches the sink.

III. PROPOSED WORK

Step 1: A Network topology shall be created using Network Simulator Software Version with moving nodes

Step 2: Nodes shall be placed randomly to map the wireless sensor network

Step 3: Nodes will be using AODV routing protocol for routing between them

Step 4: Nodes will be initialized with Constant Bit Rate (CBR) traffic for mapping the communication between them.

Step 5: Nodes will communicate with neighbours which are lying under a minimum and maximum distance between them

Step 6: Distance shall be measured by storing their current position in each node.

Step 7: Throughput and End-to-end delays shall be measured for existing network without modification and with modification to compare.

Step 8: The experiments shall be executed with different number of nodes and different communication packet sizes.

IV. CONCLUSION

The best routing path evaluation technique for forwarding the packets over the network so that the nodes with high energy shall be taking more loads and also the energy conservation will increase the working life of the nodes.

This will reduce the energy consumed by the nodes in routing and they can use the saved energy in their actual work of sensing, which causes to produce better outcomes from the sensor network.

The works of the various researchers is encouraging and have pros and cons. Most important factor to be considered in WSNs is to impose fewer burdens on networks in terms of routing updates and internal processing during data forwarding and reception which are causing lot of energy consumption due to sluggish input-output operations.

V. Future Works

From the discussion above it is expected to work for energy conservation in WSN nodes is required to be focused on maximum local processing and least processing during input-output. Also decision making for route detection can be made efficient to reduce the energy usage on each node. Energy levels of the nodes can also be taken into consideration during route decision and data transfers over the network. We are going to work further in regard for proposing a WSN network which is energy efficient and performs high speed communication even when the nodes are away from each other. We will also consider to have energy level of the nodes involved in making route decision alongwith the other metrics.

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