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EEEM: An Energy-Efficient Emulsion Mechanism for Wireless Sensor Networks

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ABSTRACT- Energy Consumption is a challenging problem in wireless sensor networks. The efficient use of energy in sensors nodes is the important considerations in wireless sensor network which is used to increase the network lifetime. Clustering mechanism is the important approach used to minimize the sensor's energy consumption. This paper proposes an energy-efficient emulsion mechanism called EEEM, to determine efficient sensor network. The EEEM primarily considers link condition, transmission range and node status and uses a clustering parameter metric called Efficacious Transmission count (ETX), to identify the quality of nodes for CH selection to construct clusters and also sleep scheduling and mobile robot mechanisms are to used to minimizing energy consumption. Simulation results shows that our proposed mechanism is effective in prolong network lifetime interms of energy consumption.

KEYWORDS- Energy efficient, Clustering, Sleep scheduling, network lifetime, wireless sensor networks

I. INTRODUCTION

The wireless sensor networks are promising network architecture which is used for wide range of potential applications including surveillance, control applications and monitoring. In general, WSNs consists of large number of sensor nodes which perform various functions such as computing, sensing and communication. Data collected from each sensor nodes transmitted to a special node is called "sink". Sensors are battery-powered devices and also charging or replacing batteries for sensor nodes is too difficult. So energy consumption is the major source of WSNs. Now a day, reducing the energy consumption in networks is a serious challenge for designing engineers. Energy efficient network is used to achieve a high delivery ratio and better network lifetime.

Wireless sensor networks used in many king of critical applications. Based on this critical expectation, sensors in such environments are energy constrained and their batteries of sensors usually cannot be recharged. So minimizing energy consumption is necessary in WSN's. Therefore, it's obvious that specialized energy-aware routing and data gathering protocols offering high scalability should be applied in order that network lifetime is preserved acceptably high in such environments.

There are N numbers of energy consumption techniques available in recent trends of wireless applications. One of main energy consuming technique is clustering. Group of sensor nodes is called clusters. Clustering is used to achieve high energy efficiency and prolong network lifetime in large-scale WSN environments. In the network structure each cluster has a leader, which is also called the clusterhead (CH) and usually performs the special tasks. The rest of the nodes in that particular clusters is called cluster member (CM). Energy efficiency is the primary challenge of WSNs. Clustering schemes strive to reduce power consumption in order to prolong the network lifespan.

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The rest of this paper is organized as follows. Section II outlines the related works. Section III describes the proposed EEEM in detail. Section IV describes simulation results, and finally, Section V provides concluding remarks.

II. RELATED WORKS

This section presents various existing energy consumption reduction techniques.

A. Dynamic Clustering Technique

In dynamic clustering [1] received power signal should be monitored from its neighboring nodes. The number of active nodes in each cluster calculated from that we can select clusterhead. This technique is used to minimize the number of inter and intra cluster communications from that we can minimize the energy consumption.

B. Energy-Efficient Clustering

In the case of energy efficient clustering solution techniques [2] distance between base station and clusters should be calculated. Clustering size also limited in EC solution. Energy efficient multihop data protocol is used to evaluate the effectiveness of the EC and also it is used to optimize the end to end delay energy-consumption. Simulation results provide comparison between HEED and EC in terms of Stable Operation Period (SOP). The number of 'alive' nodes can be calculated over simulation time.

C. Link-Aware Clustering

The existing LCM [3] evaluates the suitability of CH candidates to determine proper participants to forward data packets. The LCM is a fully distributed mechanism because the CH candidates self-determine whether they must become the CH nodes.

LCM considers node status and link condition called the predicted transmission count (PTX) to evaluate clusterhead candidates. The PTX represents the capability of a candidate for persistent transmission to a specific neighboring node. It considers energy level and link quality. The large value of PTX indicates a high possibility of becoming a CH. It provides better simulation graph compare than passive clustering. In all the case, reducing the energy consumption is fully depends on the CH selection. Compare than other techniques our proposed work which provides better energy consumption which leads to increasing network lifetime.

III. PROPOSED EECM

This section presents the proposed energy-efficient emulsion mechanism.

A. Efficacious Transmission Count

EEEM is the best energy consumption technique compare than other existing techniques. Many of the existing techniques used only one parameter for selection of clusterhead process. If we use a single parameter for clusterhead selection, it does not provide any energy-efficient network and also routing performance. The proposed EEEM considers three parameter metrics for energy efficient network formation i.e. transmit power, Node status, and link condition called, Efficacious Transmission Count (ETX). The nodes in the clusters have backup device which is used to store the ETX value. The highest priority of ETX value is used to find clusterhead nodes. This is the efficient way to select CH compare than other existing techniques.

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B. Energy-Efficient Emulsion Mechanism

One of the most challenging research tasks in the field of WSN's is controlling the energy consumption of batteries and prolong network lifetime. In EEEM, we are going to use sleep-scheduling mechanism with clustering so only it is called as emulsion mechanism. So, the architecture of our sensor work also includes Sleep Scheduling mechanism. Sleep Scheduling Mechanism (SSM) is used to improve energy efficiency of proactive wake-up. In SSM, we consider all the nodes are same sleep pattern without distinguishing among various distances and directions

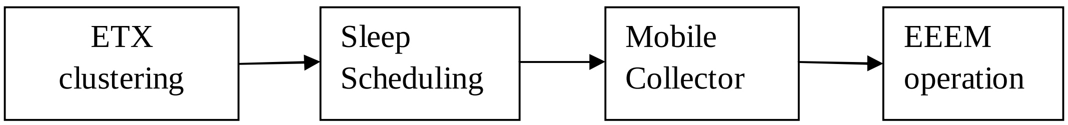

Figure 1: EEEM operation

We consider two approaches to reduce energy consumption in sleep scheduling mechanism:

1. The number of awakened node reduced
2. To shorten the active time of each nodes

The active time of awakened nodes consider as much as possible, because they could wake up and keep active only when the data transmission is takes place. For this purpose, we present a sleep scheduling protocol, which schedules the sleep patterns of awakened nodes individually according to their distance and direction away from the current data transmission of the clustering process. This will improve the scalability in large-scale WSNs.

Additionally we introduce a mobile robot. A mobile data collector, for convenience called an M-collector, could be a mobile robot or a vehicle equipped with a powerful transceiver and battery, working like a mobile base station and gathering data while moving through the field. An M-collector starts the data-gathering tour periodically from the static data sink, polls each sensor while traversing its transmission range, then directly collects data from the sensor in single-hop communications, and finally transports the data to the static sink. Since data packets are directly gathered with minimum relays and limited collisions, the lifetime of sensors is expected to be prolonged.

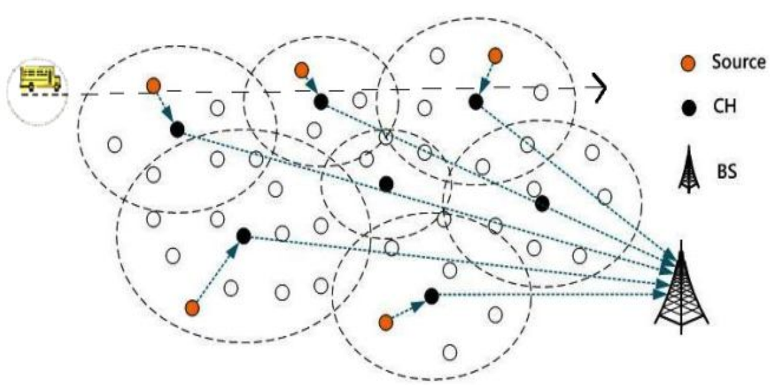

Figure 2: Mobile collector

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All these phases complete in reasonably short period of time. As soon as the setup phase finalizes, sensory data collected at CHs from their attached cluster members are forwarded toward the Backup devices following an inter cluster overlay. The selected transmission range among CHs may vary to ensure a certain degree of connectivity and to control interference.

IV. SIMULATION RESULTS

This simulation section presents the simulation environment, parameters, and metrics, followed by the simulation results. This paper used ns-2 as the network simulator and conducted numerous simulations to evaluate the EEEM performance. All sensor nodes are randomly scattered with a uniform distribution. One of the sensor nodes in clustering randomly selected as the source node. Simulation results evaluate the routing performance under scenarios with different numbers of sensor nodes. The list of all the simulation parameters and the range of values shown in Table 1.Simulation results were averaged over 12 runs. Performance evaluated by with the help of following main performance metrics:

1) Message delivery ratio: Message delivery ratio is defined as the ratio of the number of report messages the central node receives to the total number of report messages the source node sends.
2) Residual energy: measures the mean value of the residual energy of all alive sensor nodes when simulation terminates.
3) Delivery latency: Itmeans the time delay which is created by the source node while transmitting a report message to the sink.

With the help of following formulas we can optimize energy level, message delivery ratio, residual energy and delivery latency.

$$\text{Energy} = \text{Initial energy} - \text{Current energy}$$

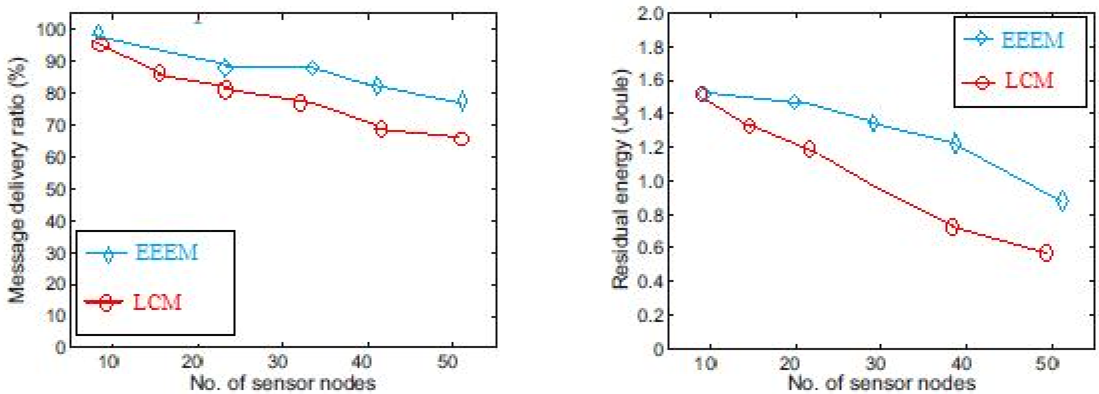
$$\frac{\text{Throughput}}{\text{Delivery ratio}} = \frac{\text{Received packets}}{\text{Send packets}}$$

$$\text{Delay} = \text{Packet received time} - \text{Starting time}$$

TABLE 1

Simulation parameters and values

Parameter	Range of values
Network size	300 m × 300 m
Number of sensor nodes	50
Communication range	50m
Packet size	1500 bits
Initial battery power	2 Joule
Simulation time	63s
E_{elec}	50 nJ / bit
E_{fusion} 5 nJ / bit / signal	



(a) (b)

Figure 3: (a) Message delivery ratio (b) Residual energy

The simulation results indicate that the proposed EEEM is superior to the other mechanisms in terms of packet delivery ratio, residual energy, and delivery latency under scenarios with different numbers of sensor nodes. The combination of sleep-scheduling and clustering is used to improve the efficiency of the network. In the EEEM, selecting the candidate with the highest priority as a CH can guarantee that the discovered routing path can remain persistent.

V. CONCLUTION

This paper has proposed an energy-efficient emulsion mechanism, called EEEM, to provide energy-efficient routing in wireless sensor networks. The EEEM introduces the efficacious transmission count (ETX) to assist in constructing cluster structures. The ETX represents the level of report quality that nodes can support and is derived from the transmit power consumption, residual energy, and link quality. Based on the derived priority level, the EEEM can select the best nodes (i.e., the CH candidate with the highest priority) to become clusterheads. Simulation results confirm that the proposed EEEM achieves a better energy consumption, packet delivery ratio and latency of delivery than the original LCM technique. On-going research is investigating the practicability of using the EEEM for data gathering in WSNs. Future research will also explore these solutions to other communication types, such as geocasting and multicasting.

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