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Efficient Low Energy Initialization and Aggregation Clustering in Sensor Network

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Abstract- wireless Sensor Networks (WSNs) have drawn in a considerable measure of attention from both the scholarly world and industry in the course of recent years. Due to the characteristics of flexibility, ease of deployment, self-organization, and so on, a variety of applications is developed base on the technologies of WSN. However, limited battery, massive raw data, and unstable wireless links leads to several constraints (such as memory constraint, energy constraint, and network capacity constraint), which restrain the execution of wireless sensor network. Energy imperatives overwhelm algorithm and system configuration trade offs for small embedded sensor gadgets. The WSN lifetime lay on the energy that can be utilized or stored by individual sensor nodes. Hence lifetime maximization through energy efficiency becomes an important issue. Data aggregation decreases energy consumption by joining data from various sensors and reject unnecessary packet transmission by filtering out redundant sensor data. In this examination an efficient low energy initialization and aggregation clustering algorithm has been proposed to enhance the performance of wireless sensor network. To test performance of proposed algorithm simulation has performed in Matlab and results are evaluated based on parameters such as sensing area, nodes initial energy, control packet length and Aggregated Packet Length. It is found that proposed algorithm has outstanding performance with respect to previous algorithm.

Keywords-Low Aggregation Energy, Low Initial Energy, Residual Energy, clustering, WSN, CH Election.

I. INTRODUCTION

Wireless Sensor Networks (WSN) are one of the first practical real-world examples of the pervasive computing paradigm - the concept of small, inexpensive, robust, networked processing devices eventually permeating the environment. The advances in semiconductor technology finally brought smaller and cheaper sensors to life. The same semiconductor manufacturing techniques miniaturized radios and processors. The system-on-a-chip (SoC) technology integrated microsensors, onboard processing and wireless interfaces which is now referred to as a sensor node or a mote. A sensor node with several features is shown in Figure 1.1.

Once networked, deeply embeddable sensor nodes can reveal phenomena that were previously unobservable. Existing and potential applications of WSNs include, among others, radiation detection, habitat sensing, seismic monitoring, video surveillance, traffic surveillance, environment monitoring, weather sensing, homeland security, forest fire detection and chemical attack detection.

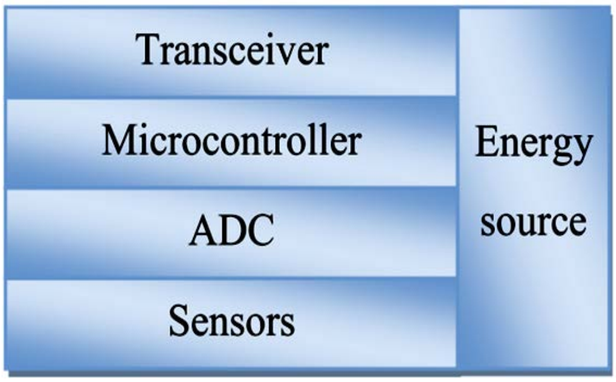

Fig. 1.1 Architecture of a sensor node

Typically, a WSN consists of hundreds or thousands of wireless sensor nodes and a sink node, where the sensor nodes own the ability of sensing, processing, communicating, and transmitting. As shown in Fig. 1.2, these sensor nodes sense the environmental factors (temperature, humidity, pressure, motion and other physical variables), communicate with each other, and transmit information. The sink node, like a base station, is deployed to collect the information.

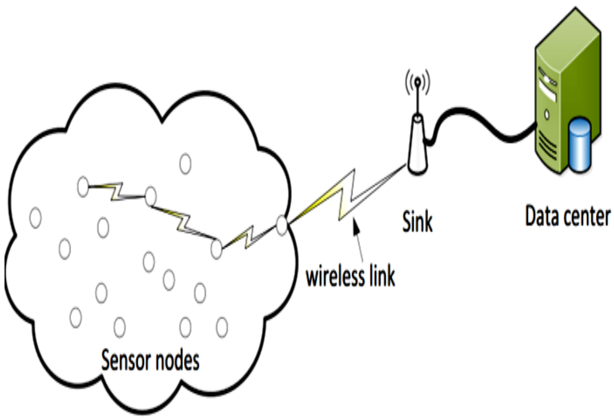

Fig. 1.2 General architecture of wireless sensor network

However, due to the limited battery power of sensor nodes, the network lifetime and performance are restricted. Meanwhile, in several applications (e.g. temperature monitoring), sensor nodes are prone to transmit redundant or correlated information to the sink, which wastes the bandwidth, thereby wasting the network capacity and accelerating the battery depletion. Therefore, how to save energy and network capacity are central challenges for researchers regarding this field of research.

Without the use of data aggregation in a WSN, sensor nodes will report all the raw data 2 to the sink. While these data tend to be redundant or correlated, leading to several drawbacks: 1) the redundant data is no sense for the application, 2) the chances of network congestion increase dramatically, 3) the network capacity is wasted, 4) energy consumption increases correspondingly.

Generally speaking, an aggregation protocol should achieve three main objectives, which are:

1. Energy saving: Data aggregation reduces the redundant or correlated transmissions in a network, which directly minimizes the energy consumption for the whole network. Since the energy limitation is a main constraint for WSN, the design of data aggregation should put energy saving as the main concern.

2. Data accuracy: Data accuracy is the accuracy between the recovered data and raw data. Sensor nodes aggregate raw data into a digest which may lost several information. Thus it is reasonable that the recovered data at sink side has some deviation comparing to raw data. Thus, how to save energy with an acceptable accuracy is a general requirement to be considered for any applications.

3. Network capacity saving: Bandwidth constraints of sensor nodes limit the net- work capacity of WSNs, so how to save the capacity has also investigated frequently. By sending less packets to the sink, data aggregation can save network capacity. Furthermore, how much network capacity has been saved can be seen as a metric to evaluate an aggregation protocol.

II. SYSTEM MODEL

A Wireless Sensor Network or WSN is supposed to be made up of a large number of sensors and at least one base station. The sensors are autonomous small devices with several constraints like the battery power, computation capacity, communication range and memory. They also are supplied with transceivers to gather information from its environment and pass it on up to a certain base station, where the measured parameters can be stored and available for the end user.

In most cases, the sensors forming these networks are deployed randomly and left unattended to and are expected to perform their mission properly and efficiently. As a result of this random deployment, the WSN has usually varying degrees of node density along its area.

Sensor networks are also energy constrained since the individual sensors, which the network is formed with, are extremely energy-constrained as well. The communication devices on these sensors are small and have limited power and range.

Both the probably difference of node density among some regions of the network and the energy constraint of the sensor nodes cause nodes slowly die making the network less dense. Also it is quite common to deploy WSNs in harsh environment, what makes many sensors inoperable or faulty. For that reason, these networks need to be fault-tolerant so that the need for maintenance is minimized.

Typically the network topology is continuously and dynamically changing, and it is actually not a desired solution to replenish it by infusing new sensors instead the depleted ones. A real and appropriate solution for this problem is to implement routing protocols that perform efficiently and utilizing the less amount of energy as possible for the communication among nodes.

Sensor devices in WSNs monitor the same event and report on them to the base station. Therefore, one good approach is to consider that sensors located in the same region of the network will transmit similar values of the attributes. This fact notices inherent redundancy in the node transmissions that may be used by the routing protocol.

This work deals with initialization Aggregation Clustering protocols for wireless sensor networks. These protocols aim to be energy-efficient in order to elongate the battery lifetime and network lifetime as a result. In most application scenarios the replacement of failed or depleted network nodes is not an option since they are placed in hazardous zones, thus it is extremely important that nodes consume the minimum amount of energy in order to make as long as possible the lifetime of the network, i.e. the time the application is still working properly.

a. Clustering

In this protocol, nodes are organized into groups called clusters. Each cluster has a local base station known as cluster head. The cluster forming mechanism is deployed to form virtual clusters and a cluster head for its cluster. These cluster heads broadcast a message to its cluster members denoting its id and a time slot. Cluster members send their data to cluster head on the irrespective time slots. Cluster head aggregates all the data collected from its cluster members removes the redundant data, and then transmit it to the base station. It minimizes the energy consumption in the network and number of messages communicated to the base station. It also reduces the number of active nodes in communication. Final result of clustering the sensor nodes is enhancing lifespan of the network. Fig. 2.1 shows a basic clustering sensor network.

A clustering scheme divides the sensor nodes in a WSN into several virtual groups, according to a certain set of rules. In a cluster structure, sensors may be assigned a different function or status, such as cluster member or cluster head

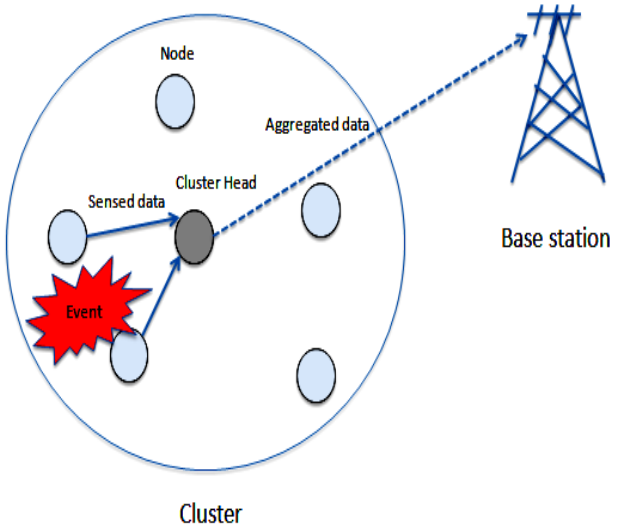

Fig. 2.1 a Basic Clustering Sensor Network.

b. Data Aggregation

Sensors may generate a lot of unnecessary information. So, alike packets from several sensors can be combined to reduce amount of transmissions. Data aggregation techniques are being used for achieving energy efficiency and to optimize data/message transfer in the routing protocols.

III. PROPOSED METHODOLOGY

The corresponding hierarchical routing and data gathering protocols imply cluster-based organization of the sensor nodes in order that data fusion and aggregation are possible thus leading to a lot of energy being saved. Each cluster has a cluster head (CH) which is the leader of the cluster and usually performs special functions like fusion and data aggregation. Every cluster also contains several sensor nodes as members. Cluster formation leads to a two-level hierarchy where the CH nodes form the higher level of the hierarchy and the members form the lower level. The sensors regularly transmit their data to their respective CH nodes. CH nodes aggregate the data (which ensures that the total number of transferred packets is reduced) and transmit this aggregated data to the base station. The CH's exhaust more energy because of the large amount of data transmission to longer distances. The solution into periodically re-elect new CHs in each cluster so as to balance the energy consumption among all the sensor nodes in the network. Proposed algorithm requires low initial energy by sensor nodes. The algorithm and flow of process of proposed work is demonstrated in Fig. 3.1.

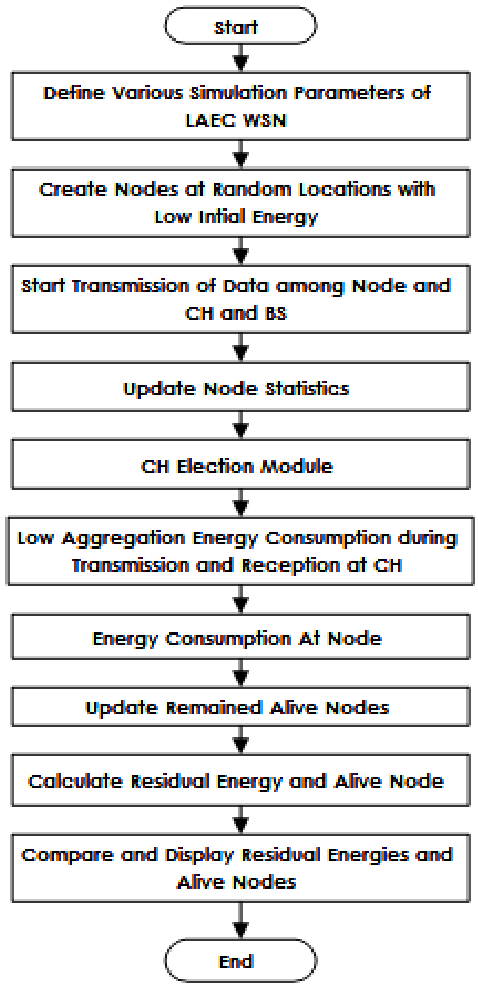

Fig. 3.1 Flow Chart of the Proposed Methodology.

To design proposed algorithm various simulation parameters of LAEC (Efficient Low Energy Initialization and Aggregation Clustering) WSN (Wire Less Sensor Network) are defined in Matlab simulation environment. To make system energy efficient nodes are created at random location with low energy efficiency. To test algorithm data among nodes and CH and BS are transmitted. To perform transmission update node statistics. CH election module elects cluster heads. Low aggregation energy consumption has been recorded during transmission and reception at CH. Calculate energy consumption at Node also. Update remained alive nodes and calculates residual energy and alive node. Compare and display residual energy and alive nodes. Table 1 shows the parameters used to simulate proposed work and there corresponding values. The fundamental simulation parameters are sensing area which is taken 500X500 with low initial energy 0.5J which was taken 2J in previous work. Energy cost 0.5e-007J for transmission and reception of 1 bit information. Capacity of transmit amplifier is E_{fs} = 10pJ/bit/4m^2 .Length of control packet is considered is 100bit and length of aggregate packet considered is 2000bit. The simulation and analysis of results are carried out based on parameters discussed above.

Table I: Proposed Network Simulation Parameters.

Parameters	***Values***
Sensing Area	500 x 500
Nodes Initial Energy	0.5J
Energy Cost of Sending/Receiving 1 Bit	0.5e-007J
Transmit amplifier (if d to BS < do)	E_{fs} = 10pJ/bit/4m^2
Transmit amplifier (if d to BS > do)	E_{mp} = 0.0013pJ/bit/m^4
Control Packet Length	100bit
Aggregated Packet Length	2000bit

IV. SIMULATION RESULTS

In wireless sensor networks, longer network lifetime and more network capacity are required in various of applications, such as long-term monitoring. Thus the problems of energy and network capacity consumption are considered central to the sensor research theme. In previous studies, several researchers demonstrate routing protocols can append feature of saving energy but still its challenging issue to be concerned in this work.

It is important to identify the proper metrics to use for evaluating the performance of the proposed scheme as data aggregator in a WSN environment. The performance of efficient low energy initialization and aggregation clustering (ELEIAC) algorithms in general can be measured by using the following metrics:

- Number of Alive Nodes vs. Rounds Energy Savings
- Residual Energy vs. Rounds

Several aggregation works benefit from data collecting structure, and the structure is organized based on similar raw data. However, by observing real datasets, abnormal data often appears, while the data evolution is more stable. Therefore, to avoid the impact of instability of raw data, a data-independent aggregation scheme ELEIAC is proposed and simulated. Proposed methodology organizes sensor nodes which own similar evolutions into a group to perform data aggregation, targeting at improving the accuracy and saving more energy.

The proposed algorithm has implemented and simulated a simulation of network topology using MATLAB. A topology is totally described by the number of stationary sensors N belonging to the network and their locations. During the execution of our simulations, a given source and destination pair remains in the evaluated set until communication between them fails due to energy depletion. To analyze the performance of proposition ELEIAC, compare ELEIAC with DDEC. First, the initial energy is sated and the number of nodes as 100. The results are illustrated in Fig. 4.1 and Fig. 4.2 for the number of alive node and residual energy respectively for 100 rounds. Fig. 4.1 shows number of alive nodes vs number of rounds for n=100 rounds and Fig. 4.2 Residual Energy vs. Rounds for n=100. In Fig. 4.1, and Fig 4.2 shows that proposed ELEIAC outperforms DDCHS in terms of number alive nodes.

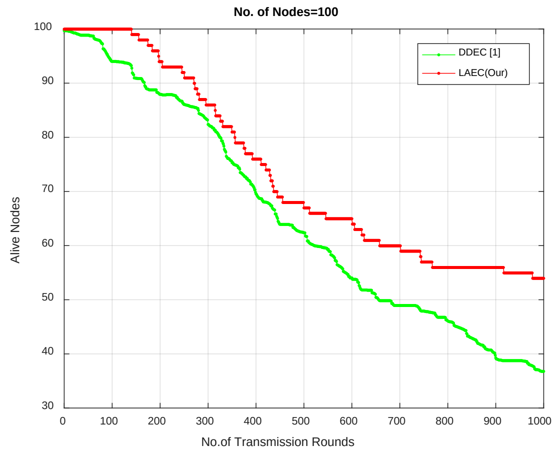

Fig. 4.1 Number of Alive Nodes vs. Rounds for n=100.

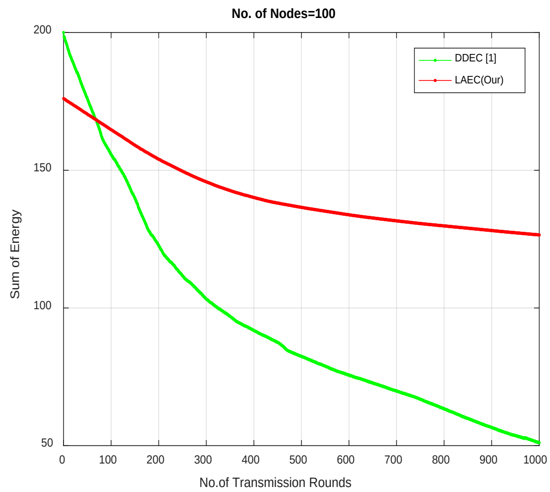

Fig. 4.2 Residual Energy vs. Rounds for n=100.

The network parameters used in proposed work such as Number of alive nodes and residual energy, are calculated with respect to number of rounds. The graphs show that the proposed algorithm outperforms against previsions algorithm. The Fig. 4.3 Shows that the Number of Alive Nodes for 200 rounds two different colors in graph represents proposed ELEIAC and previous DDEC algorithm. Fig. 4.4 shows Residual energy vs. rounds for n=200. Proposed algorithm residual energy lasts for 200 rounds compared to DDEC which lasts for less rounds. Hence the proposed algorithm distributes energy more equally among all nodes compared previous to DDEC.

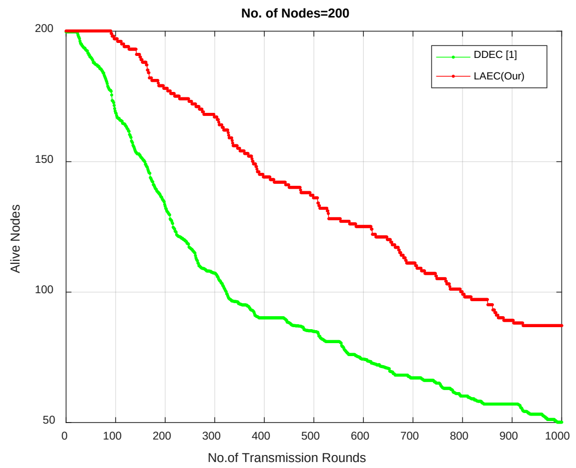

Fig. 4.3 Number of Alive Nodes vs. Rounds for n=200.

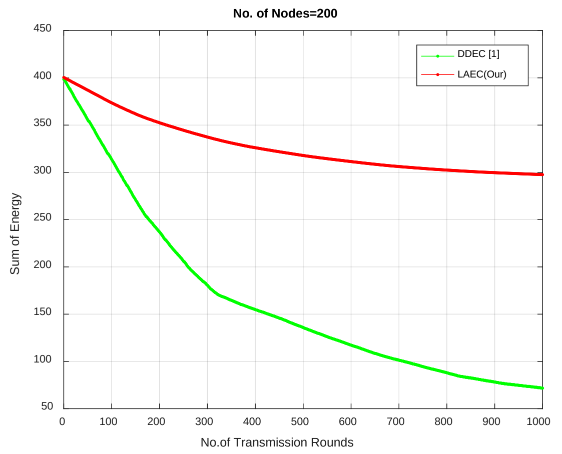

Fig. 4.4 Residual Energy vs. Rounds for n=200.

V. CONCLUSION

In this investigation work Wireless Sensor Networks (WSNs) have been designed and simulated in MATLAB for gathering the data and send back to users via the sink. In WSNs, every sensor node is furnished with a small battery and communicates with its neighbors over wireless links. When sensors transmit the data, they use their energy in transmission. Thus, the sensor energy is the main impediment for improving overall WSN performance such as lifetime. A basic angle in the outline of WSNs is to spare energy and keep the system useful for whatever period of time that conceivable. The objective of this examination is to propose an efficient low energy initialization and aggregation clustering (ELEIAC) to reduce the number of transmissions in order to enhance the network lifetime. This issue is address by investigating simultaneously aggregation, routing and clustering. A global solution has proposed in this work that aims to enhance the network lifetime and energy efficiency. The proposed Efficient Low Energy Initialization and Aggregation Clustering algorithm (ELEIAC) parameters are compared with previous density, distance and energy based clustering (DDEC) algorithm, it is found that proposed ELEIAC outperforms for same parameters and resources.

Future work could be directed towards achieving different quality of service levels for different types of data. An extension for further investigate will be on temporal-spatial data aggregation and to study the packet loss in data aggregation, and to investigate the impact on energy and accuracy.

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