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Optimal Density and Distance Based Adaptive Low Aggregation Energy Clustering WSN

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Abstract - Sensor networks are designed to monitor specific areas or conditions to keep under surveillance for various parameters like temperature, humidity, motion, heat, speed etc. The wireless sensor networks are has limited lifetime of data collection due to battery operated sensors. Energy consumption of nodes reduces by optimizing the routing of data collection to the base stations using energy efficient routing protocols. In this work and adaptive low aggregation energy clustering based routing is developed which is inspired from different previous routing algorithms and conditions to make efficient routing to get the longer lifetime of the network. The network simulation outcomes shows its merits over previous work.

Keywords – Adaptive Clustering, Low Aggregation Energy, Residual Energy, WSN, CH Election, Density, Distance.

I. INTRODUCTION

The recent advancements in wireless communications and electronics has led to the development of low-cost, low-power, multifunctional small smart sensors. These sensors should have the ability to sense, process data, and communicate with each other via a wireless connection. A wireless sensor network is an infrastructure comprised of number of spatially distributed autonomous wireless sensors nodes to monitor a phenomenon in a specified environment, and to cooperatively forward their measures (collected data) through the network to a desired sink(s).

Wireless Sensor Networks (WSNs) have attracted a lot of attention from both the academic world and industry over the past ten 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 energy constraint, memory constraint, and network capacity constraint), which limit the performance of wireless sensor network. How to deal with the above constraints has become a hot topic for researchers. Data aggregation which is a way for saving energy and network capacity has been frequently investigated. By studying the correlations of raw data, data aggregation reduces the data packets in the network, thereby saving communication cost and easing network congestion. In this examination an optimal density and distance based adaptive low aggregation energy clustering WSN has been reported.

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. 1.1, 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. The small, distributed, and feasible sensor nodes accelerate the development of WSN. As shown in Fig. 1.2, there are varieties of applications benefiting from WSNs, such as building monitoring, health care, smart agriculture, military surveillance, environment monitoring, and detection issues.

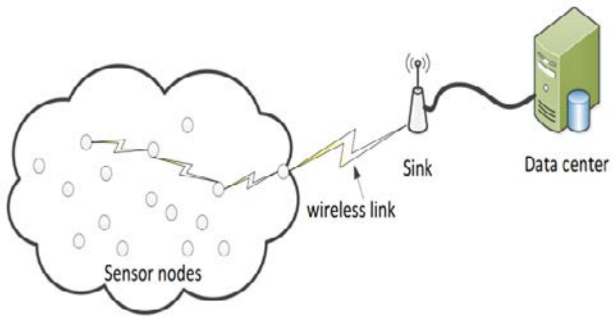

Fig. 1.1 General Architecture of WSN

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. By investigating energy consumption in one sensor node, we found that the major power drain occurs from wireless communication. Thus in order to save energy, a reasonable solution is to reduce the communication activity. Data aggregation, which can reduce communication by reducing the number of data packets transmitted in the network, is considered as a fundamental way to save energy.

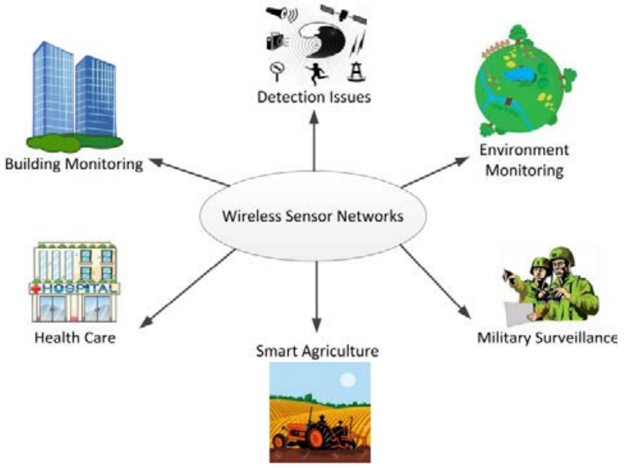

Fig.1.2 various applications based on WSN.

II. CLUSTERING

Clustering is the process of grouping the data into classes or clusters, so that objects within a cluster have high similarity in comparison to one another but are very dissimilar to objects in other clusters. Dissimilarities are assessed based on the attribute values describing the objects. Often, distance measures are used [1]. The field of clustering has undergone major revolution over the last few decades; it has its roots in many areas, including data mining, statistics, biology, and machine learning. Clustering is characterized by advances in approximation and randomized algorithms, novel formulations of the clustering problem, algorithms for clustering massively large data sets, algorithms for clustering data streams, and dimension reduction techniques [2].

Principle routing protocol in cluster based WSN. The key idea of LEACH is that the clustering algorithm proposes to reduce the energy consumption used by data forwarding from sensor nodes to the BS, and the network life time is divided into rounds. Each round has two phases the Setup phase or Cluster formation and Steady State Phase (data transmission) figure 2.1. In the Setup Phase, the decision to be a cluster head is made locally at the node level. Each node n selects a random number between 0 and 1. If the random number is less than a threshold T(n) , the node selects itself as a CH and announces itself as a CH. Otherwise, the node will be a regular node and will wait for CH's advertisements.

A regular node elects one CH to join and send a joining message. After receiving the joining messages, the CH creates and broadcasts the transmission (TDMA) schedule. The TDMA schedule contains a time slot for each node to communicate with the CH. When a node receives the schedule table, then it can obtain a time slot and it goes sleep waiting for its allocated time to communicate with its CH.

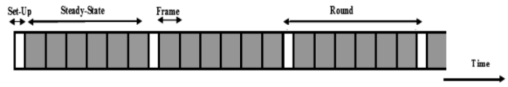

Fig. 2.1 Time line showing LEACH operation. Adaptive clusters are formed during the set-up phase and data transfers occur during the steady-state phase

In the Steady State Phase the data transmission phase is broken down into a set of frames. In each frame a regular node sends its obtained data to the CH (according to its TDMA time slot) then enters into the sleep mode waiting for its time slot in the next frame. Meanwhile the CH remains awake to receive all members' data. At the end of each frame, the CH aggregates the received data signals with data sensed by the CH itself and then forwards the aggregated data signal to the BS. The process will be repeated until the completion of all the frames. By the end of the last frame, the cluster has completed a single round, and all nodes enter the setup phase to selec new cluster heads for the next round

III. PROPOSED METHODOLOGY

In this examination work an optimal density and distance based adaptive low aggregation energy clustering WSN algorithm has been proposed. Implementation of proposed algorithm has done in MATLAB. In wireless sensor networks, longer network lifetime and more network capacity are required in variety 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 proposed algorithm density and distance approach has been used. In proposed algorithm cluster area is divided in to perpendicular diameters and cluster head has been selected by the density of member nodes and its distance from cluster head. 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. Data accuracy is the accuracy between the recovered data 3 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.

In the existing work, several aggregation schemes rely on the raw data to group sensor nodes, in order to aggregate information. However, abnormal data often appears in raw data. Thus the data instability definitely impacts the performance of such schemes. In addition, several aggregation functions are specified for a certain data (e.g. temperature data) or a type of network property (e.g. grid network), which limits the adaptivity of these functions.

Therefore, motivated to propose density and distance based adaptive low aggregation energy clustering. Fig. 3.1 shows the flow chart of proposed work in Matlab.

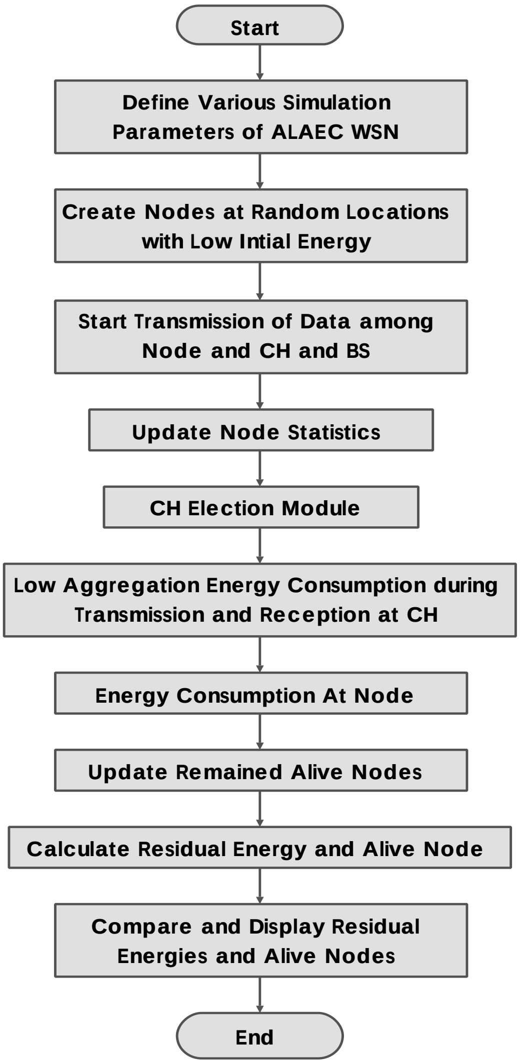

Fig.3.1 Flow Chart of the Proposed Methodology

Aggregation function is the computation part of data aggregation, which is responsible for how to do aggregation. It defines the methodology of executing aggregation at sensor node level. At the initial studies of aggregation functions, simple operations (MAX, MIN, Average etc) are used to process data. As the improvement of accuracy requirements, more complex aggregation functions are proposed. They are based on mathematical theories, and can achieve higher recover fidelity than the simple operations.

To implement and execute proposed algorithm flow of execution is shown in Fig. 3.1 are described as follows. To execute proposed algorithm first various simulation parameters are defined in MATLAB. Create network node at random location with low inertial energy. Start transmission of data among node and cluster head and base station. Update nodes statistics. Use cluster head election module. Apply low aggregation energy consumption during transmission and reception of CH. Energy consumption at node. Update remained alive node after transmission and reception. Calculate residual energy and alive node. Compare and display residual energies and number of alive nodes.

Table 1 shows the simulation parameters are considered to examine the performance of proposed algorithm in Matlab. The fundamental parameters listed in table 1 are Area of Sensing Network, Initial Energy of Nodes, Sending/Receiving Energy for 1 Bit, 4. Transmit amplifier (if d to BS < do), Transmit amplifier (if d to BS > do), Control Packet Length, Aggregated Packet Length.

Table 1: ODAECR Network Simulation Parameters

Parameters	***Values***
Area of Sensing Network	500 x 500
Initial Energy of Nodes	1J
Sending/Receiving Energy for 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

A MATLAB software based simulation has been carried out to examine the performance of proposed algorithm and to verify the results of proposed algorithm. Since sensor nodes are randomly deployed in the area, network might have high density and low density regions which means that a large number of nodes are deployed in some regions and in some areas nodes are deployed further away from each other, so a clustering approach is connected for such a network which think about the density of every node to shape the clusters. In proposed algorithm, an adaptive low aggregation energy clustering technique is used for wireless sensor network which is considers the nodes density.

To evaluate the effectiveness of the overall performance of the network, different simulation analyses have been done so as to demonstrate how proposed methodology has better execution against past base algorithm. Subsequent to gathering nodes' data, the BS at that point elects a lot of eligible nodes to treat as cluster heads toward the current round. A node is eligible if its current residual energy is greater than the average energy of all live nodes. When the eligible node set is defined, the BS performs the clustering algorithm to partition the network into the desired number of clusters. The output of this function is the set of clusters with a cluster head for each cluster. After the network is clustered, the length of the current round is computed by the round time controller.

To study the system performance for the aggregation, a randomized selection method is used for each round; a random value has been chosen.

Based on the parameters considered from Table 1 some simulation outcomes while executing proposed algorithm are discussed in Figure 4.1 to Figure 4.6. Figure 4.1 shows the plot of number of Alive nodes per transmission round for 100 transmission rounds and Figure 4.2 shows the corresponding Residual Energy for 100 rounds.

Figure 4.3 shows the throughput proposed algorithm for 100 rounds in terms of packets send to base station.

Figure 4.4 shows the plot of number of Alive nodes per transmission round for 200 transmission rounds and Figure 4.5 shows the corresponding Residual Energy for 200 rounds

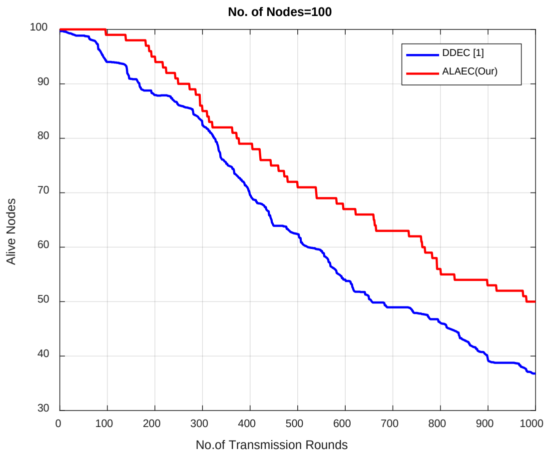

Fig. 4.1 Number of Alive Nodes vs. Rounds for 100 Rounds

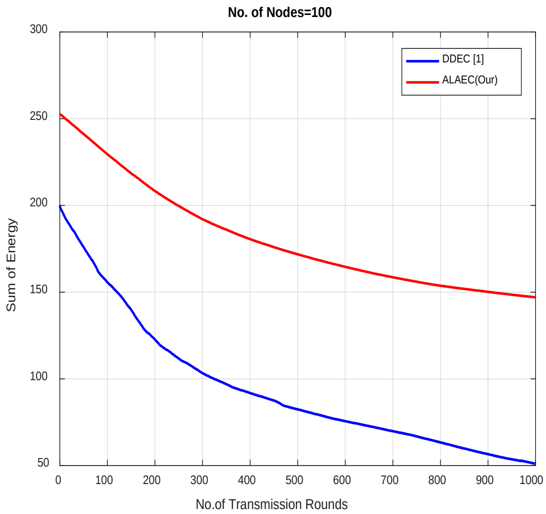

Fig. 4.2 Residual Energy vs. Rounds for 100 Rounds

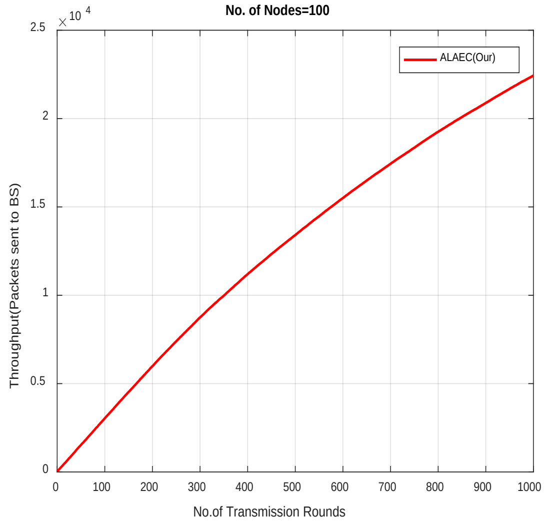

Fig. 4.3 Throughput for 100 Rounds

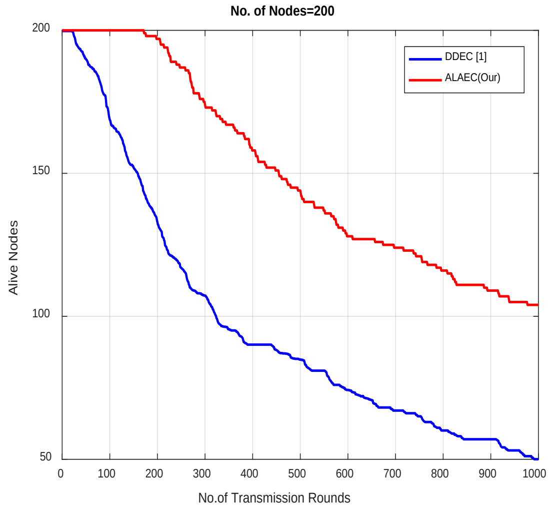

Fig. 4.4 Number of Alive Nodes vs. Rounds for 200 Rounds

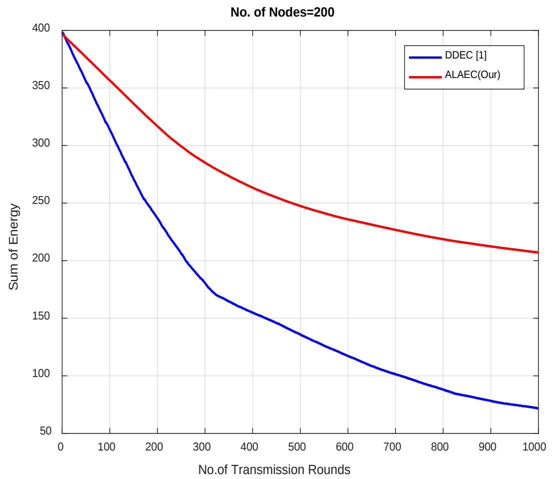

Fig. 4.5 Residual Energy vs. Rounds for 200 Rounds

Figure 4.6 shows the plot of throughput for 200 rounds in terms of number of packets send to base station.

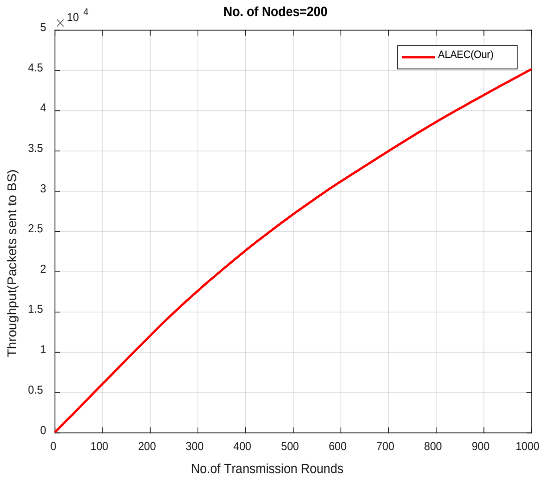

Fig. 4.6 Throughput for 200 Rounds

V. CONCLUSION AND FUTURE SCOPE

In this examination work an optimal density and distance based adaptive low aggregation energy clustering WSN has been proposed. It is important for the network designers to have a basic understanding of the clustering attributes such as the number of clusters; how frequently clusters are rebuilt; cluster size; number of hops (single hop or multihop), and they must be conscious of energy consumption in cluster-based WSN examination. Such perceptiveness and awareness promote general discussion about the clustering problems and their potential solutions, and often assist with the available energy being spent in an efficient way that conveys the intended design goals of the WSN application. The ultimate objective of this work was to design a set of effective energy management schemes to achieve the design goals, lifetime longevity and the desired amount of data delivered. The performance of proposed algorithm has been verified based on simulation in MATLAB. The simulation and result analysis verify that proposed work has achieved its research objectives.

Despite the fact that the algorithm designed in this examination show huge enhancements for energy in WSN, It is accepted that there is still an opportunity to get better, and these feature our future research headings. Packet loss in data aggregation and secure data aggregation.

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