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Energy Efficient Aggregation In Wireless Sensor Networks Using Artificial Intelligence Based Aggregator Election

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Abstract:- A wireless sensor network (WSN) consists of a lot of tiny sensing devices, which can monitor environment or other events. Because these devices run on battery, energy is an extremely critical resource for them. Thus, energy-efficient method need be carefully designed for data aggregation. Most of the existing energy-efficient algorithms always forward packets by cluster head or data aggregator. Both the structure of clustering and data aggregation can realize to gather data with energy-efficient method. In this paper, considering the concept of data aggregation we proposed a energy efficient data aggregator election (EEDAE) algorithm to reduce the energy consumption, when a WSN is used to gather data. The goal of this basic approach is to use the architecture of cluster and artificial intelligence technique to elect the data aggregator efficiently and gather data from the nodes sensed interesting event to the cluster head (CH) so as to reduce the transmission energy in a cluster. Our simulation results show that EEDAE can improve energy efficiency, and thus prolong network lifetime.

Index:- *Cluster-Head, Aggregation, EEDAE Kohonen neural network model, Energy efficiency.*

I. INTRODUCION

A wireless sensor network (WSN) of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on. The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a micro controller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. A sensor node might vary in size from that of a down to the size of a grain of dust, although functioning "motes" of genuine microscopic dimensions have yet to be created. The cost of sensor nodes is similarly variable, ranging from a few to hundreds of dollars, depending on the complexity of the individual sensor nodes. Size and cost constraints on sensor nodes result in corresponding constraints on resources such as energy, memory, computational speed and communications bandwidth. The topology of the WSN can vary from a simple star network to an advanced multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding. Area monitoring is a common application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. A military example is the use of sensors detect enemy intrusion; a civilian example is the geo fencing of gas or oil pipelines. Area monitoring is most important part. The medical applications can be of two types: wearable and implanted. Wearable devices are used on the body surface of a human or just at close proximity of the user. The implantable medical devices are those that are inserted inside human body. There are many other applications too e.g. body position measurement and location of the person, overall monitoring of ill patients in hospitals and at homes. Body-area networks can collect information about an individual's health, fitness, and energy expenditure. issues in wireless sensor networks, some are listed below

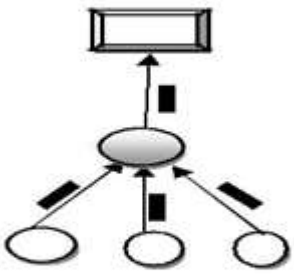
- Medium access scheme
- Routing
- Multicasting
- Pricing scheme
- Security
- Quality of service provisioning
- Self- Organization

Energy management

- Addressing and service discovery
- Scalability
- Deployment considerations

II. DATA AGGREGATION

Data aggregation is a process of aggregating the sensor data using aggregation approaches. The general data aggregation algorithm works as shown in the below figure. The algorithm uses the sensor data from the sensor node and then aggregates the data by using some aggregation algorithms such as centralized approach, LEACH(low energy adaptive clustering hierarchy),TAG(Tiny Aggregation) etc. This aggregated data is transfer to the sink node by selecting the efficient path



Data aggregation is very crucial techniques in wireless sensor network. Because with the help of data aggregation we reduce the energy consumption by eliminating redundancy..In this paper we discuss the data aggregation approaches based on the routing protocols, the algorithm in the wireless sensor network. And also discuss the advantages and disadvantages or various performance measures of the data aggregation in the network.

A multidisciplinary research area such as wireless sensor networks (WSN) have been invoked the monitoring of remote physical environment and are used for a wide range of applications ranging from defense personnel to many scientific research, statistical application, disaster area and War Zone.. Therefore, this paper proposed the efficient and effective architecture and mechanism of energy efficient techniques for data aggregation and collection in WSN using principles like global weight calculation of nodes, data collection for cluster head and data aggregation techniques using data cube aggregation.

Data aggregation has been widely applied as efficient techniques in order to reduce the data redundancy and the communication load in Wireless Sensor Networks (WSNs). However, for dynamic scenarios, structured protocols may incur high overhead in the construction and the maintenance of the static structure. Without the explicit downstream and upstream relationship of nodes, it is also difficult to obtain high aggregation efficiency by using structure-free protocols. Therefore, the packet transmission converges from both spatial and temporal points of view for the data aggregation procedure. Finally, simulation results validate the feasibility and the high efficiency of the novel protocol when compared with other existing approaches.

Existing energy-efficient approaches to in-network aggregation in sensor networks can be classified into two categories, tree-based and multi-path-based, with each having unique strengths and weaknesses. In this paper, we introduce Tributary-Delta, a novel approach that combines the advantages of the tree and multi-path approaches by running them simultaneously in different regions of the network. In addition, we give a multi-path algorithm for frequent items that is considerably more accurate than previous approaches. These algorithms form the basis for our efficient Tributary-Delta frequent items algorithm. Through extensive simulation with real-world and synthetic data, we show the significant advantages of our techniques. For example, in computing Count under realistic loss rates, our techniques reduce answer error by up to a factor of 3 compared to any previous technique.

The data in wireless sensor networks is organized in an efficient manner using data aggregation and data dissemination protocols. Due to the energy constraints in sensor nodes, energy-efficient data aggregation protocols are used to save the node energy and enhance the network life cycle. Deploying additional sensor nodes in the network reduce the resource constraints but increase the rate of data redundancy. This limitation is addressed by the data aggregation protocols-in sensor networks. Data aggregation protocols use cluster head node to collect the data,aggregate the data and forward the data to the base station.. Analysis for structure-free, structure-based, distance and time-based data aggregation protocols are given in detail. Simulation results indicate that the energy and throughput rate are improved in the cluster-based data aggregation protocols as compared to the structure-free, time-based or search-based data aggregation protocols.

III. RELATED WORK

Energy attribute has always been the topic of concern in the area of wireless sensor network (WSN). Although, abundant research has been conducted for addressing the energy issues in WSN, but the majority of the techniques were explored with various flaws that couldn't effectively address such issues. Hence, the proposed paper introduces a technique that performs a hierarchical clustering technique in order to enhance the total network lifetime of the sensor motes in the wireless transmission area. The technique applies non-deterministic approach and adopts intra-phase and inter-phase clustering. Every phase of the non-deterministic parameters enforces the optimal participation of the cluster members in the process of selection of cluster head. Finally, the simulation is performed in varied parameters and compared with the more standard LEACH protocol to find that the proposed technique highly enhances the network lifetime by 42%**.**

Wireless sensor network is one of the most promising technology in wireless network. To design a sensor network, improving the lifetime of sensor node is critical issue. For these reason researchers in these field pay great attention to Medium Access Control (MAC) protocol. As most of the nodes are placed in remote and hazardous area, so when the power is down it is difficult to recharge them or it is not possible to replace them. For these reason the main concern of researchers is how to utilize the medium in a power effective manner. With advance of these various MAC protocols are introduced and lots of recent works are going on. LEACH protocols are one of these protocols which introduce clustering technique. In this paper, a method for intra-cluster communication based on CSMA and an extended cluster head selection algorithm. Also figure out mathematical comparison between LEACH protocol and our proposed method. The protocol selection depends on the application requirements and hardware characteristics. LEACH is suitable

Routing is a basic service for intelligent environmental monitoring system. However, traditional routing protocols cause unnecessary energy consumption due to the high communication overhead. In this paper, proposed RERP, energy efficient cluster-based routing protocol for intelligent environmental monitoring system. RERP improves LEACH protocol by limiting the selection range of cluster head. RERP also achieves reasonable cluster head election by considering residual energy, relative density and centroid distance. Simulation results show that RERP can save 54thpercentile energy more than LEACH after2000clusteringrounds.When the network size is 500,RERP can still guarantee 99.6% node alive after 2000clustering round.

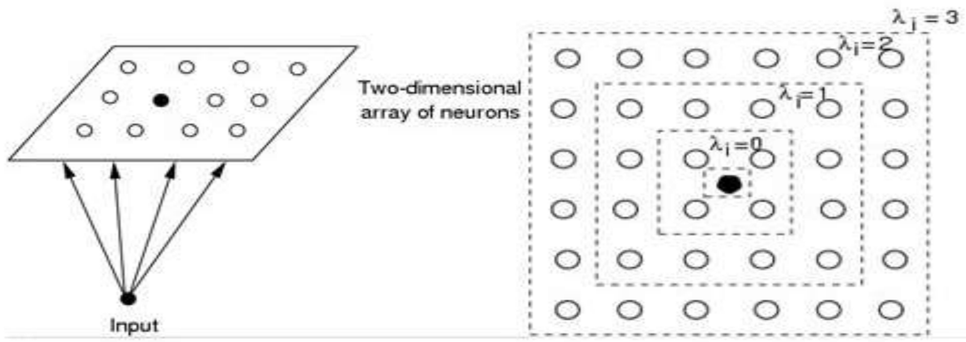
IV. SYSTEM DESCRIPTION

4.1 SERVICE MODEL

In the proposed algorithm, we follow the cluster-based routing method. So, more attention is given to the selection of data aggregator node which plays a major role in packet forwarding and data gathering. To select a data aggregator we are going in for artificial intelligence, a network model method that describes the phenomenon of collecting the nodes of similar types. In particular, the model has been proven very useful in maintaining the self organization in wireless sensor networks. There are many methods available for electing the data aggregator in the wireless sensor networks. As mentioned earlier, we are using Residual energy, Energy Density, Distance, Higher energy density.

4.1.1KOHONEN NETWORK MODEL

Kohonen network model used mostly in self organizing maps where supervising is not necessary. The model works in such a way that the similar types are nodes are selected and the best node is elected as the output node.



(a) (b)

Kohonen neural network model

The Algorithm

nodes are D_j.
set decay rate.
set alpha
set minimum alpha
while alpha is > minimum alpha
{
for each input vector
{
for each node x
{

- compute:

$$D_j = \sum_i (w_{ij} - x_i)^2$$

- find index j such that Dj is a minimum.
- update the weights for the vector at index j and its neighbors:

$w_{ij}(new) = w_{ij}(old) + \alpha[x_i - w_{ij}(old)]$
}
}
reduce alpha
optionally, reduce radius of topological neighborhoods at specific times.
}

4.2 CLUSTER FORMATION

Assume *N* sensor nodes in a M x M square region are divided into *k* clusters, with representing the standard transmission radius for message exchange during the set-up stage of clusters.

V. PARAMETERS TAKEN

Energy efficiency in wireless sensor network is enhanced by electing the data aggregator node by considering the parameters like Residual energy (RE), Energy density(ED), Distance (d).

5.1 RESIDUAL ENERGY:

Residual energy is defined as energy present in the node at the particular time. The node energy spent in transmitting and receiving the data packets.The residual energy of the node can be calculated as follows:

$$RE=I+(E_T+E_R)t$$

Where
I =initial energy
E_T=transmitting energy
E_R=receiving energy
$ET=p_T+T_T$
p_T-no.of packets transmitted
T_T-time for each packet to travel
$ER=p_R+T_T$
p_R-no.of.packets received
T_T-time for each packet to receive at node

5.2ENERGY DENSITY:

Energy density is defined as the sum of the residual energy of each node present in the cluster. Energy density plays a very important role in electing the data aggregate. Energy density can be calculated as follows:
$ED(t)= R_e(t)+R_e(t+1)+....................R_e(n)/Distance(i,k)*coverage\ area$

5.3 DISTANCE

The distance of the node can be calculated by using the general Distance formula between two nodes. Distance of the node from the base station plays a vital role in efficiently using the resource.

5.4 ALGORITHM

Input: Residual energy (RE), Energy Density(ED),Distanc(d)

1. NODE DEPLOYMENT PHASE:
    Node Deployment
2. CLUSTERING PHASE:
    The nodes in the network are clustered according to the density of the node.
    Node Clustering
3. COMPUTATION PHASE:
    Calculating the residual energy,energy density and distance of the higher energy nodes from the network
    Residual energy(RE)
    Energy Density(ED)
    Distance(D)
    Higher energy density(HED)
    Table(T**)**
4. ELECTION PHASE:
    Consider the cluster with higher energy density(CHE)
    Let CHE>= Threshold value.
    Select the node with higher residual energy(HRE).
    Select the node with higher density(HD).
    if(HD=HRE)
        Elect HD as data aggregator node
    else
        search for HRE in and around the CHE
        If HRE present then
        HRE =data aggreagtor.

CALCULATING RESIDUAL ENERGY AND DISTANCE OF HIGHER DENSITY CLUSTER 1

NODE	RESIDUAL ENERGY	DISTANCE
20	9	20
25	8	25
32	8	26
28	8	27
26	7	30
29	6	28
35	7	35
	53	

CALCUATING RESIDUAL ENERGY AND DISTANCE OF HIGHER DENSITY CLUSTER2

NODE	RESIDUAL ENERGY	DISTANCE
32	7	30
45	6	32
48	6	33
52	6	34
60	5	36
44	5	40
53	4	41
	37	

From the above table the cluster with higher energy density is selected for electing the data aggregator node.

VI. SIMULATION ENVIRONMENT

We evaluation of the performance of proposed algorithm via simulations in Mat lab. The simulation environment is set up with the parameters listed in the below table.

Parameter Name	Value
Number of the sensor nodes	100
Length of the packet	4000 bit
Initial energy of the sensor nodes (E_{init})	10J
Energy consumption on circuit (E_{elec})	50nJ/bit
Channel parameter in free-space model (E_{amp})	10pJ/bit/m^2

VI. ANALYSIS

Wireless Sensor Networks are battery powered and hence the scarce energy is an important and has to be utilized effectively and efficiently. The goal of the WSNs is to increase its lifetime and maximize its throughput. In earlier works, cluster based routing protocols have used different parameters such as residual energy, distance from cluster head to the base station, etc to elect the cluster head. The cluster head drains out energy faster than all other nodes in the cluster. And more over density of clusters may vary in the network. Hence it is quiet important to consider residual energy of all the nodes in the cluster . In addition, the density of nodes in a cluster plays the critical role in overall average energy of the cluster, a parameter that needs to be computed for the disconnection of the cluster resulting in the partition of the network. There must be a mechanism which enables uniform utilization of energy across all nodes in the cluster. And as well as use those nodes along with a group of neighboring nodes with higher residual energy as cluster head to increase the lifetime and minimize the throughput in the network.

Efficient Clustering

In order to overcome this problem the Energy Balanced Routing Protocol (EBRP) [4] is designed by constructing a mixed virtual potential field in terms of depth, residual energy and energy density. The main goal of this technique is to force the packet to sent through the more energy dense area towards the sink, so that it can protect the nodes with relatively low residual energy. This protocol has considerably improved network lifetime, coverage ratio and throughput. Further it is necessary to check the looping problems to improve the integrated performance of the entire network.

The optimal number of aggregator are chosen based on the residual energy and the distance to the base station. Finally, the temporary cluster heads are replaced with optimal value. Thus, the network energy load is more balanced and prolongs the network lifetime. In our work, we have identified the cluster head based on energy density, residual energy and distance. This method effectively balances the energy utilization, prolongs the network lifetime and maximizes the throughput.

Network Lifetime (NL):

Network Lifetime (NL): It is defined as the maximum total time duration for which the network provides fair connectivity among all the nodes without network partition.

Packet Delivery Ratio (PDR):

It is the ratio of actual packet received by the sink to the total number of packets sent from the source.

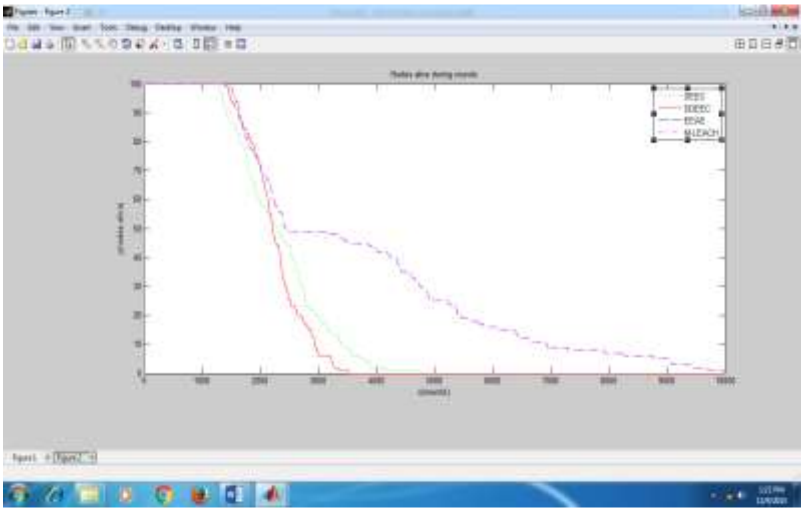
Network Throughput (NT): It is defined as the rate of packet transmission in the network per unit of time.

The energy efficient data aggregator election algorithm resulting in uniform utilization of energy among all the nodes of the network that enhances the lifetime of the network. It is observed that the Network Lifetime increases by 18% over the other two protocols.

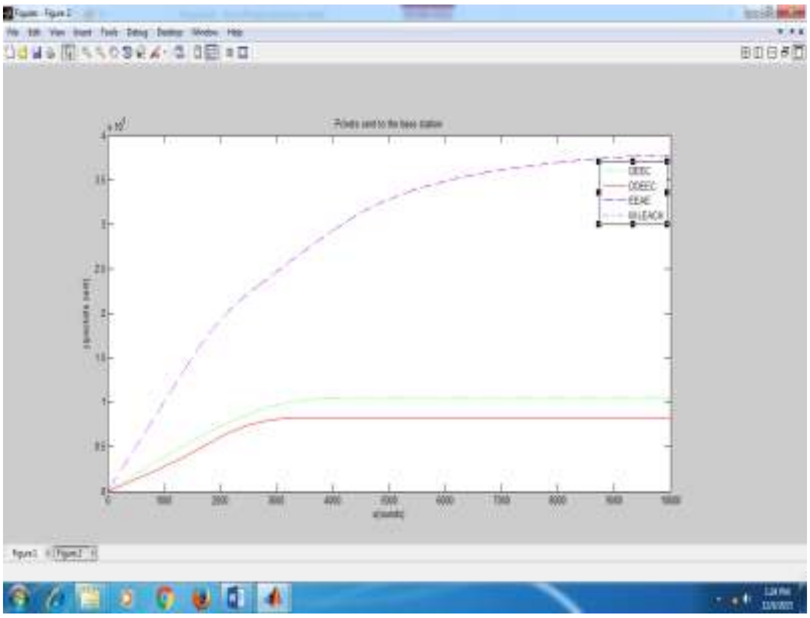
VII. PERFORMANCE ANALYSIS

7.1SIMULATION RESULTS:

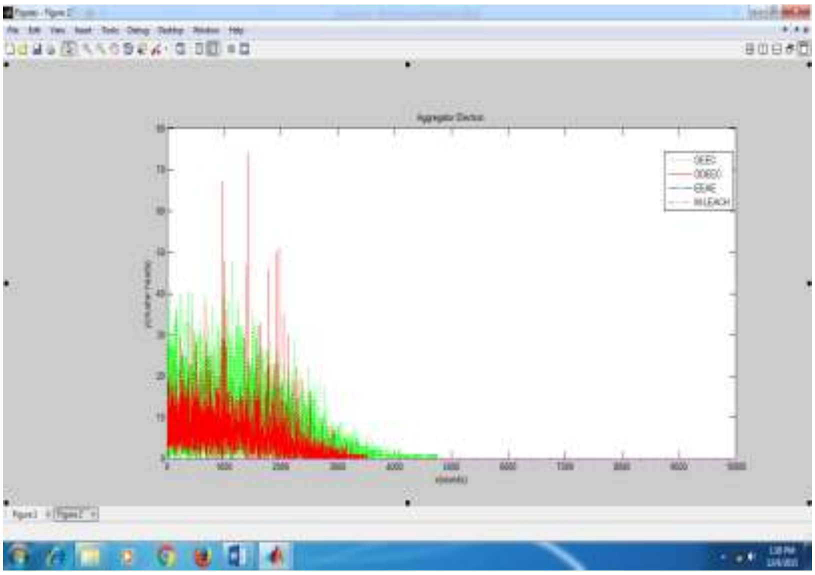
Simulation is done with the help of Mat Lab. Here we have compared our proposed EEAE algorithm with the LEACH and HEED protocol. The comparison is done by the No. Of packets sent to BS node, No. Of dead nodes and the No. Of rounds the aggregator is selected. The result so we obtained is depicted below.



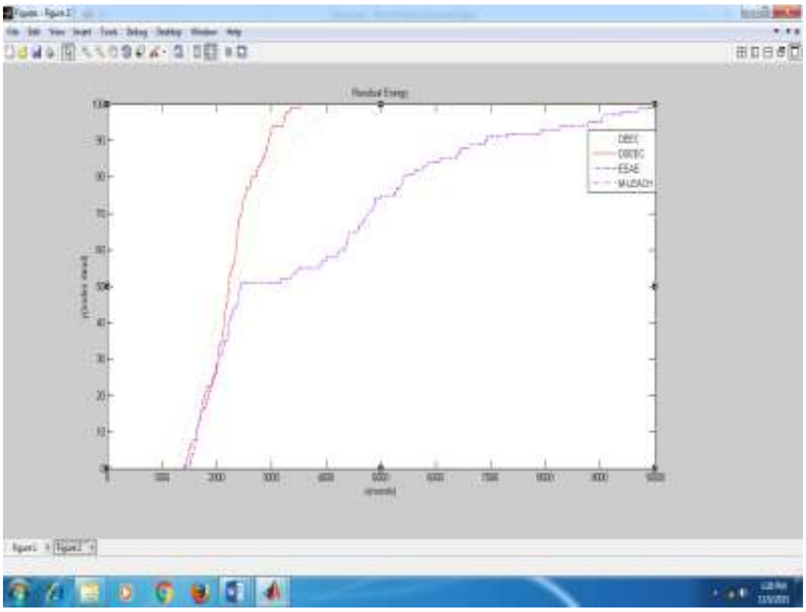
7.1.1 Alive nodes in the network



7.1.2 Packets sent to the base station



7.1.3 Aggregator election



7.1.4 Residual energy of the node

VIII. CONCLUSION AND FUTURE WORK

In WSN, abundant research has been conducted for addressing the energy issues in WSN, but the majority of the techniques were explored with various flaws that couldn't effectively address such issues. Hence, the proposed paper introduces a technique that performs a hierarchical clustering technique in order to enhance the total network lifetime of the sensor motes in the wireless transmission area. The technique applies non-deterministic approach and adopts intra-phase and inter-phase clustering. In this paper, we have developed a cluster based election of aggregate thereby achieves good packet delivery ratio, more network lifetime while attaining low delay, overhead, minimum energy consumption than the existing scheme HEED scheme while varying the number of nodes, node speed, and throughput and stability weight. In second phase, additionally, replication of service requests can be explored to reduce delays and improve percentage of completed service. Another direction of work can be to explore the effect of dropping service requests when expected delay is higher than the application requirements to offload the network resources.

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