Generating Sensor Nodes and Clustering Energy Efficiency in Wireless Sensor Network

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Abstract-Technical advance in Wireless Communication, computation and hardware technologies enable new device known as sensor nodes. In this paper we propose a new approach of generating sensor nodes in different geographical area of a wireless sensor network field. A distance from origin based cluster head selection algorithm is proposed for selecting cluster head for the generated nodes. This algorithm helps for improving the sensor network lifetime and load balancing. Energy conservation is a significant concern in the Wireless Sensor Networks (WSNs). A new technique is proposed by comparing the sending energy of selected cluster head and non-CH among some of wireless sensor nodes based on net distance with base station. The sending energy is calculated and it shows the energy conservation of network.

Keywords - Wireless Sensor Network (WSN), Sensor Node (SN), Cluster Head (CH), Base Station (BS), Energy Efficiency (EE).

I. INTRODUCTION

The WSN network provides a bridge between the real physical and virtual worlds. It allows the ability to observe the previously unobservable at a fine resolution over large – temporal scales. It has a wide range of potential applications to industry, science, transportation, civil infrastructure and security. There are many challenges present in the area of wireless sensor network. The most familiar challenges in the area of WSN are energy efficiency, responsiveness, robustness, self-Configuration and adaption. Apart from the above issues, the security issues during the accessing of information within the WSN are one of the current research areas. The generating SNs and its clustering in WSNs shown in fig.1.

WSN are wireless networks that usually consists of great number of far distributed devices that are equipped with sensors (instrument that measure quantities in our environment) to monitor physical or environmental phenomenon. WSN are emerging as both an important new tier in the IT ecosystem and a rich domain of active research involving hardware and system design, networking, distributed algorithm, programming models, data management, security and social factors [1].

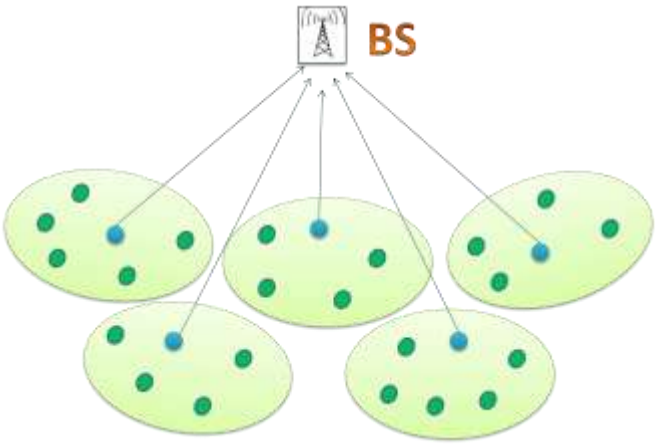

Fig. 1: The Overall view of Generating SNs and Clustering.

The basic idea of sensor network is to disperse tiny sensing devices; which are capable of sensing some changes of incidents or parameters and communicating with other devices, over a specific geographical area for some specific purpose like target tracking, surveillance, environmental monitoring etc. Today's sensors can monitor temperature, pressure, humidity, soil make up, vehicular movements, noise levels, lighting conditions, the presence or absence of certain kind of objects or substances, mechanical stress levels on attached objects, and other properties. In case of WSN the communication among sensor is done using wireless transceivers. While routing strategies and wireless sensor network modelling are getting many preferences, the security issues are yet to receive extensive focus. This paper focuses on a secured energy optimization techniques implementation over WSN.

WSN consists of battery propagated sensor devices with computing, data processing and communicating components. The ways the sensor are deployed can either is in a controlled environment or in an uncontrolled

environment. In the uncontrolled environment, security for sensors becomes extremely important during accessing information or data.

II. WSN ARCHITECTURE MODEL

WSN architecture consists of many components such as SNs, interface with sensors and energy source usually a battery or an embedded form of energy harvesting, gateway or access points, network manager which is responsible for configuration of the network, scheduling communication between devices, management of the routing tables and monitoring and reporting the health of the network, Security manager for the generation, storage, and management of keys. The architecture of WSN can be represented as shown in figure 1.1.:

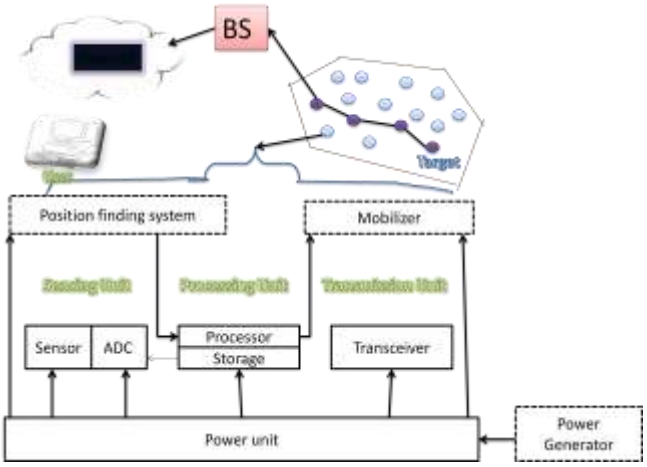

Fig 1.1: The Structural view of WSN.

For optimization, energy efficient routing techniques are required. Routing protocols are responsible for discovering and maintaining the routes in the network. The routing protocols differ by their applications and network structure. These routing techniques are classified into three types such as: flat routing, hierarchical routing and location based routing .Sensor networks plays a major role in many aspects of society including home automation, consumer electronics, military application, agriculture, environmental monitoring, health monitoring.[1] WSN formed by hundreds or thousands of nodes that gathers information and forward it to sink node .The SNs are have the capacity to communicate with each other, perform computation and to sense their surroundings from WSN.[2].Functions such as sensing ,tracking, alerting can be obtained due to the cooperation among the SNs.[3].Wireless sensors becomes very useful for monitoring natural phenomena, environmental changes ,controlling security, monitoring military applications and tracking friendly forces in the battle fields[2].Wireless data transmission is most critical among the sources of energy consumption in SNs.

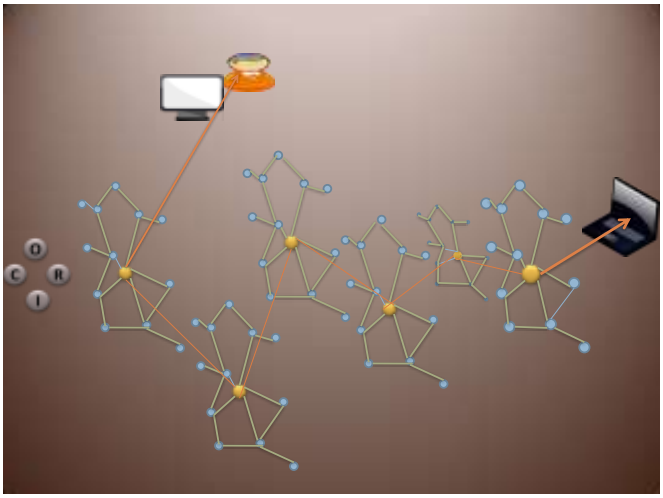

Fig 1.2: The Structural view of SN in WSN.

A stable design and structure is expected in WSN during transfer of data among the sensors. It should be done in a safety environment without any problem. The main objective in designing WSN is consuming less energy and increasing the lifetime of the SNs. This is because of the limitation of the power resources and the difficulties of replacing the batteries of wireless sensors as shown in fig.1.2. In terms of implementation, WSN presents vast challenges. Several key attributes are there that designer must carefully consider which have importance in WSNs

- Generating nodes.
- Cost of clustering
- Selection of cluster heads and sub cluster heads.

Synchronization

- Data aggregation
- Repair mechanism
- Quality of Service(QoS)

III. CLUSTERING IN WSN

The Clustering is the process of dividing the sensor networks in to small manageable units. To improve the scalability of the network and to prolong the lifetime of SNs this clustering approach is followed. It is an important factor in achieving the energy efficiency routing of data within the network.[12].

The Energy efficient routing in WSN provides two broad classification of approach. They are:

- Clustering approach
- Tree based approach

In WSN cluster is a group of SNs. Among these group one node will act as a CH[9,10].and remaining nodes are act as member nodes. No of exchanged communication is reduced by the help of clustering process, which results in low consumption of battery power of each individual sensor nodes. Hence the life span of sensor network is increased. The selection of CH is based on the energy level of that particular node or it can based on minimum distance from base station. The CH will take the responsibility to communicate with the base station (BS). The remaining nodes can then be put to a sleep state.

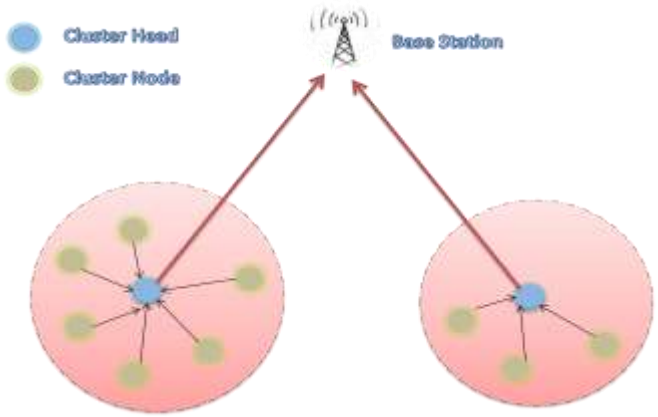

Fig 2.1: The CH model in WSNs

IV. RELATED WORK

To choose CH in ad hoc networks and in WSN many greedy algorithm have been proposed. These are based on the criteria of highest degree, lowest ID, highest-ID and node weight, residual energy, probability etc. There may be combination of these factors. Clustering technique may be classified basing upon cluster size, namely Single hop and Multi-hop. In protocol LEACH [6] (Low Energy Adaptive Clustering Hierarchy) CH is elected based on randomly generated value between 0 and 1. If this randomly generated value is less than the threshold value then the node becomes CH for the current round. For WSN, LEACH [11] is the first hierarchical cluster-based routing protocol .Generally, this approach partitions the nodes in to clusters .A dedicated node with extra privileges are referred as CH. This CH is then responsible for creating and manipulating a TDMA(Time Division Multiple Access) schedule .CH will send the aggregated data from member nodes to the BS, where these data is needed using CDMA(Code Division Multiple Access).

The Another routing protocol PEGASIS(Power-Efficient Gathering in Sensor Information System)[4][5] has gain improvement over LEACH by making only one node to transmit data to the BS. Here every node transmits its data to its nearest /neighbour node in its data fusion phase. PEGASIS starts with the farthest nod e from the BS. HEED(Hybrid Energy –Efficient Approach) protocol based on distributed clustering in ad- hoc sensor networks.[7]. It periodically selects cluster heads according to the combination of their residual energy, and communication cost. The modified version of HEED is Distributed Weight Based Energy efficient Hierarchical Clustering(DWEHC) [8]. It focus on providing more balanced cluster size and intra cluster topology. There are two basic clustering parameters used by HEED: one is the residual energy, other is the communication cost. An average minimum reach ability power i.e the minimum power levels required by all the nodes within the cluster range to reach the CH defines the communication cost. In HEED, each node must be mapped to exactly one cluster, and each node belongs to its only CH within one hop shown in fig.3.1.

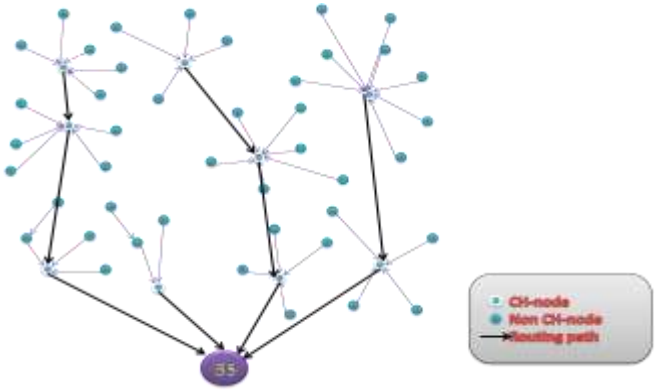

Fig 3.1: The Multiple CH in WSNs.

The real world conditions such as heat, light, pressure, humidity etc are measured by the SNs. The SNs then convert these conditions in to an analogue or digital representation. The following are the steps for CH selection:

- Generating SN.
- Clustering process
- CH selection.

- Select remaining nodes as child nodes
- Sensing information from child node and send to the corresponding CH
- Transforming information to the BS.

V. PROPOSED WORK

In WSN first the sensor nodes will be generated. After creating the clusters the CH will be selected. A n algorithm is proposed here for selecting CH based on distance from origin method.

PROPOSED ALGORITHM:

Perform the following steps for each and every cluster.

SELECT_CLUSTERHEAD(n,A)
Begin:
Step 1 : Let we have a set N of n nodes in a cluster viz. A= {N_1,N_2, N_3… N_n}
Step 2 : Calculate the distance of one node to all nodes.
for i=1 to n do
for j=1 to n do
N_{ij} = distance from N_i to N_j
endfor
endfor
Step 3: Calculate the distance from origin to all nodes.
Dis_{ij} = distance from origin (0,0)
Step 4 : Calculate distance from BS to each node for all nodes.
for i=1 to n do
DBSi = Distance from BS to S_i
endfor
Step 5: Calculate the net distance with base station for each node
for i =1 to n do
$NetDBS_i$=DBS_i + Ni
endfor
Step 6 : Select the cluster head based on all NetDBS values.
$NetDBS_i$ =Min ($NetDBS_1$, $NetDBS_2$, $NetDBS_3$, $NetDBS_4$… $NetDBS_n$)
And corresponding node will selected as CH
End.

VI. MATRIX REPRESENTATION FOR CH

Step 1: Let we have a set A of n nodes in a cluster viz. A= {N_1, N_2, N_3… N_n} and let the distance from each node to all other nodes within cluster can be represented as

Step 2: Let the sum of all distances from a single node to all other nodes are represented as

dis(1,1) → Distance between N_1 to N_1

dis(1,2) → Distance between N_1 to N_2

……

dis(1,n) → Distance between N_1 to Nn

dis(2,1) → Distance between N_2 to N_1

dis(2,2) → Distance between N_2 to N_2

……

dis(2,n) → Distance between N_2 to N_n

……
……..
dis(i,j) → Distance between N_i to N_j
……
……
dis(n,1) → Distance between N_n toN_1
dis(n,2) → Distance between N_n to N_2

……

dis(n,n) → Distance between N_n to N_n

Representing distance matrix from one node to other node in above algorithm.

$$\begin{pmatrix} dis(1,1) & dis(1,2) & dis(1,3) & dis(1,4) & \dots & dis(1,n) \\ dis(2,1) & dis(2,2) & dis(2,3) & dis(2,4) & \dots & dis(2,n) \\ \vdots & & \ddots & & \vdots & \\ \vdots & & & & \vdots & \\ dis(n,1) & dis(n,2) & dis(n,3) & dis(n,4) & \dots & dis(n,n) \end{pmatrix}$$

Step3: Add all distance from one node to all other nodes. Find the value of D(i).

dis(1)=d(1,1) + d(1,2) + d(1,4) + ...d(1,n)

dis(2)=d(2,1) + d(2,2) + d(2,4) + ...d(2,n)

dis(3)=d(3,1) + d(3,2) + d(3,4) + ...d(3,n)

……
……
dis(i)=dis(i,1)+dis(i,2)+dis(i,3)+dis(i,4)+ .....dis(i,n)
$1 \le i \le n$

…….
…….
dis(n)=dis(n,1) + dis(n,2) + dis(n,4) + ...dis(n,n)
Calculate the distance vector for each node representation of step 3 in algorithm.

$$\begin{pmatrix} Dis(1) & dis(1,1) + dis1,2) + & ... & dis(1,n) \\ Dis(2) & dis(2,1) + dis(2,2) + & ... & dis(2,n) \\ \vdots & = & & \vdots \\ Dis\ (n) & dis(4,1) + dis(4,2) + & .... & dis(n,n) \end{pmatrix}$$

Step4: Now the distance from base station (DBS) to each node, respectively

DBS(1) = Distance between BS to N_1

DBS(2) = Distance between BS to N_2

DBS(3) = Distance between BS to N_3
……..
……..
……..
……..
DisBS(n) = Distance between BS to N_n
Distance from base station DisBS(i), where $1 \le i \le n$, vector representation to all nodes of step 4 in algorithm.

$$\begin{pmatrix} DisBS(1) & Distance\ between\ (1)\ and\ BS \\ DisBS(2) & = & Distance\ between\ (2)\ and\ BS \\ \vdots & & \vdots \\ DisBS(n) & Distance\ between\ (n)\ and\ BS \end{pmatrix}$$

Step5: Now the net distance with base station (NetDBS)

Calculate the net distance with base station $NetDBS_i$, where $1 \le i \le n$, vector for each node representation of step 5 in algorithm.

$$\begin{pmatrix} NetDBS(1) & Dis(1) & DisBS(1) \\ NetDBS(2) & = Dis(2) + & DisBS(2) \\ \vdots & & \vdots \\ NetDBS(n) & Dis(n) & DisBS(n) \end{pmatrix}$$

Step6: Select the CH

NetDBS(i)=Minimum (NetDBS(1), NetDBS(2), NetDBS(3), NetDBS(4)…

NetDBS(n))

According to the above mentioned sequence, it is found that node N(i) has smallest distance in comparison to other SNs. Now we can conclude that if node N(i) is selected as aCH, it will consume less energy in comparison of other nodes in the network.

VII. SIMULATION

TABLE 1. The Radio Parameters

Parameter	Definition	Unit
Eclec	Energy dissipation	10-100
E amp	Energy dissipation rate to run transmit amplifier	100pj/bit/m2
K	Data length	Bit (16)
D	SN transmission range	as per the net distance

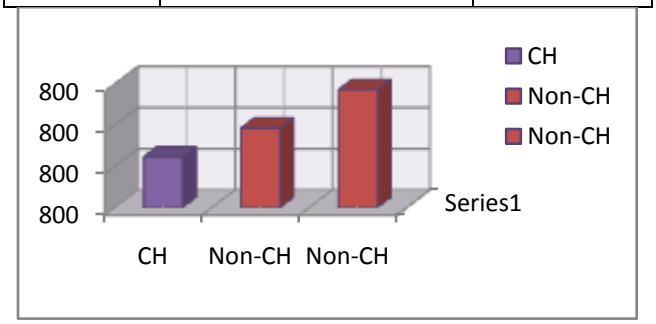

Fig 6.1: The Energy in CH and non-CH in WSNs.

VIII. CONCLUSION

In WSN clustering hierarchy, cluster head selection is a major issue. It is also equally important to make the network energy efficient. The power consumption can be optimized by rotating the cluster head inside the individual clusters. In this paper a new technique is proposed for generating nodes in different area dynamically. It also proposed a new approach of cluster head selection by finding the minimum distance from origin. Among some of sensor nodes cluster head is selected based on net distance with base station. Main objective of this proposed technique is to prolong the life time of the whole network. The number of nodes which will remain alive for a longer period of time will increase.

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