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A Review on Energy Efficient Protocols Implementing DR Schemes and SEECH in Wireless Sensor Networks

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***ABSTRACT* :** *Nowadays Wireless Sensor Network (WSN) plays a very important role for transferring the data from source to destination but energy is one of the major challenges in these networks. WSN consists of thousands of nodes which consume energy while transmitting the information and the node having high data transmission and reception or high load lost their energy earlier and network life time gets reduced. Clustering and Cluster head selection are important parameters used to enhance the lifetime of the WSN. These are used to be good approaches to overcome energy problem. In this paper, we discuss various protocols, the Divide and Rule (DR), Density Controlled Divide and Rule (DDR), Improved Density Controlled Divide and Rule (IDDR) and Scalable Energy Efficient Clustering Hierarchy (SEECH) protocols for energy efficient routing protocol in WSN.*

***Keywords*: -** *Clustering, Energy efficiency, WSN, DDR, SEECH.*

I. INTRODUCTION

WSN consists of hundreds to thousands of sensing nodes that sense data from the environment, capture it, process it and transmits to the Base Station (BS). In recent time, WSN become most popular because of its low cost, small size, adoption to critical environments and so on. So they are used in variety of applications like Multimedia Surveillance, Traffic Avoidance Systems, Advance Health Care, Industries, Dense forests, Critical Environment etc. These applications include sensors/nodes that collect data and send it to the BS. The nodes are distributed randomly and engage themselves to collect and transmit the data, this makes more energy to be consumed. The sensors/nodes having heavy load of data transmission and reception requires much more energy and become dead node. These dead nodes lost their energy much earlier and prematurely get dead.

So clustering technique like is used to overcome this problem. Two types of clustering are used: Static clustering
and Dynamic clustering. In static clustering, the size of clusters is fixed and the nodes send their data to a fixed Cluster Head (CH) until their whole energy get consumed while in dynamic clustering the size of cluster varies in every cycle i.e. the nodes send their data to the CH which is close to that particular node. So clustering and CH techniques are used to minimize the consumption of the energy of each node.

A comparative study is done between static clustering and dynamic clustering and CH selections in DR, DDR, IDDR and SEECH..

II. RELATED WORK

The research methodology we studied, use different protocols for getting energy efficient WSN.

1. Clustering

While transmitting data from node to sink maximum energy get lost depending upon the distance between node and sink. So clustering technique is used, The transmission is either single hop or multi-hop, in single-hop CH collects data and sends to BS while in multi-hop the CH far away from BS collects data and sends it to the next nearest CH and then again next nearest CH and finally to BS.

Advantage of clustering:

Collected data transmitted to BS from CH, so number of nodes involved in data transmission to destination is reduced. The direct communication nodes to BS get reduced by single-hop and multi-hop communication.

The clustering used is of two types: Static Clustering and Dynamic Clustering.

1.1 Static clustering:

In static clustering, the region formed and numbers of nodes both are fixed. The nodes of that particular region send their data to the CH of their own region till their energy get destroyed and replaced by new one. DR and DDR both use static clustering.

1.2 Dynamic Clustering:

In dynamic clustering, the regions are formed but nodes are not fixed. The nodes send their data to the CH which is at minimum distance from that node so in this case energy consumed is less. IDDR and SEECH use dynamic clustering.

2. Cluster Formation

For cluster formation the first step is to take BS as centre so its coordinates are taken as reference point to form concentric squares. Whole of the region gets divided into n concentric squares, say (n = 3) having three squares with I_s (internal square), M_s (middle square), O_s (outer square) [1].

The equations used for making concentric squares are:

Coordinates of top right corner of I_s, $T_r(I_s)$

$$T_r(I_s) = (C_p(x) + d, C_p(y) + d) \quad (1)$$

Coordinates of bottom right corner of I_s, $B_r(I_s)$

$$B_r(I_s) = (C_p(x) + d, C_p(y) - d) \quad (2)$$

Coordinates of top left corner of I_s, $T_l(I_s)$

$$T_l(I_s) = (C_p(x) - d, C_p(y) + d) \quad (3)$$

Coordinates of bottom left corner of Is, Bl(Is)

$$B_l(I_s) = (C_p(x) - d, C_p(y) - d) \quad (4)$$

Where d is the distance from reference point and d is multiplied by a factor α which is 1 for I_s, 2 for M_s, 3 for O_s and so on.

Divide each square into CR (Corner Region) and NCR (Non Corner Region). For dividing area between I_s and M_s take top right and bottom right of I_s as reference point then

$$T_r(I_s(x+d,y)) \text{ and } B_r(I_s(x+d,y) \text{ forms NCR2} \quad (5)$$

$$T_l(I_s(x,y+d)) \text{ and } T_r(I_s(x,y+d)) \text{ forms NCR3.} \quad (6)$$

$$T_l(I_s(x - d, y)) \text{ and } B_l(I_s(x - d, y)) \text{ forms NCR4} \quad (7)$$

$$B_r(I_s(x, y - d)) \text{ and } B_l(I_s(x, y - d)) \text{ forms NCR5} \quad (8)$$

The areas left in between I_s and M_s forms CR i.e. CR2, CR3, CR4, CR5. Similarly for division between M_s and O_s take T_r and B_r of M_s as reference for forming NCR6, T_r and T_l to form NCR7, T_l and B_l forms NCR8, B_r and B_l forms NCR9.The areas left in between M_s and O_s forms CRs. Fig. 1 shows formation of clustering in DR[1].

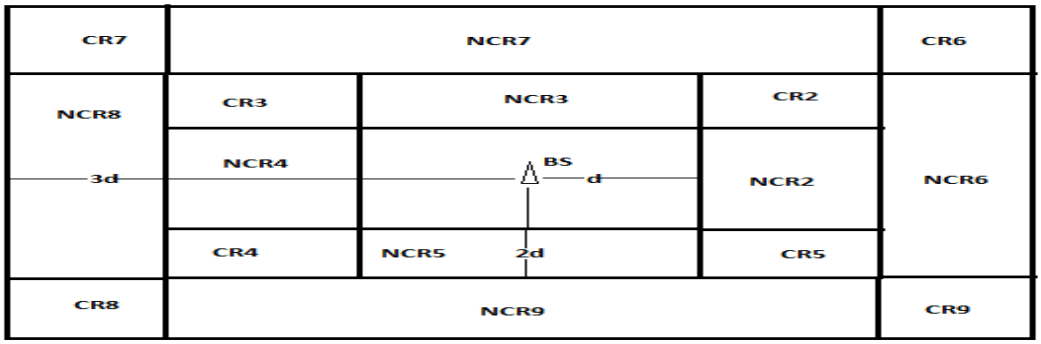

Fig.1.Cluster Formation in DR.

Figure 1 shows how the clusters, their NCRs andCRs are formed with BS as the reference coordinate.

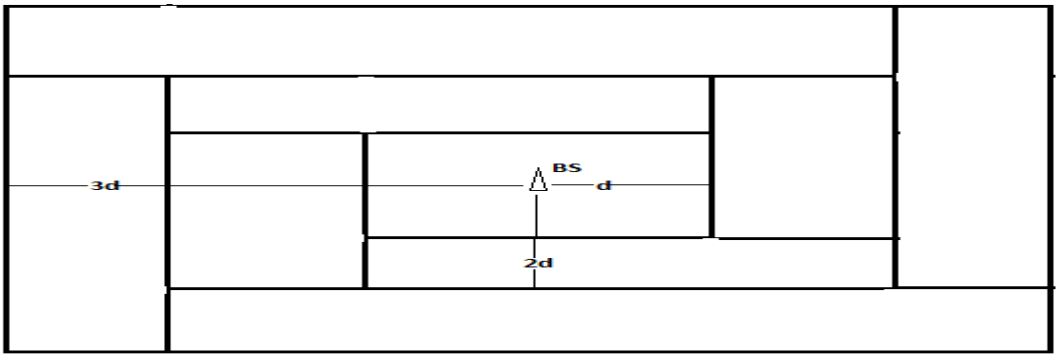

Fig.2.Cluster Formation in DDR and IDDR.

Figure 2 shows cluster formation in DDR & IDDR [2-3]. In DDR & IDDR, CRs and NCRs are not formed Figure 3 shows how cluster formation is done in SEECH. Before each round a start phase is established in which nodes collect its information like its distance from the BS, number of neighbors in a specific radius etc. then share data with other nodes and then derive its degree. After the round starts, in each round node has two phases: setup phase and steady state phase. In setup phase cluster, CH relays and paths are determined by the nodes and in steady state phase, data are collected and transmitted to the BS [4].

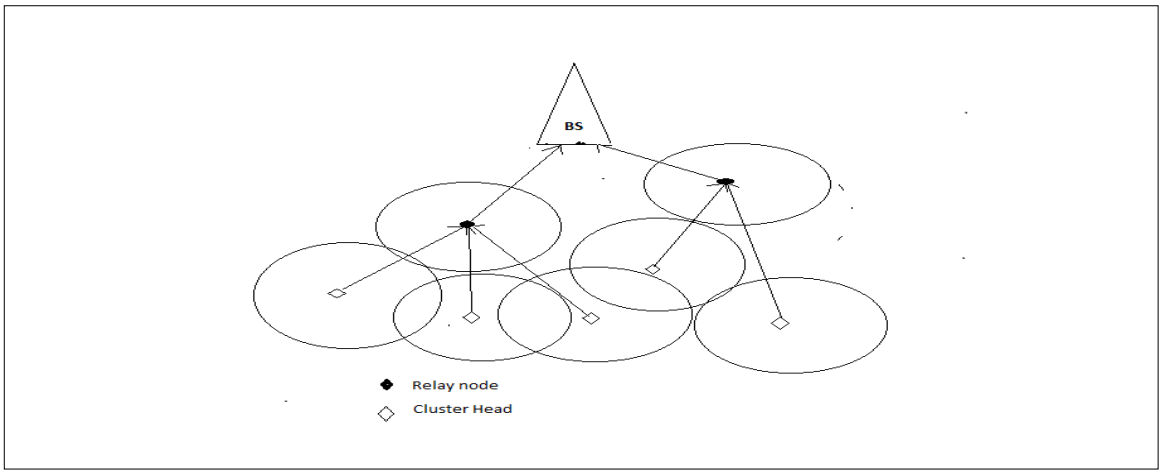

Fig.3.Cluster Formation and nodes distribution in SEECH.

3. Cluster Head Selection

In WSN, the data transmission from source (node) to destination (BS) is via CH to eliminate the problem of power/energy consumption. There are different strategies used for CH selection.

In DR & DDR, CH selection is based on the distance between CH and BS [1-2]. The internal concentric square (close to the BS) need not to form CH, the nodes of that region directly communicate with the BS. While outer concentric squares form centre of there region as reference point and the node closer to it become CH and in next round next closest node becomes CH and so on.

In IDDR, CH selection is based on the residual energy of the node in each round. Node having highest residual energy selected as CH in every round [3].

In SEECH, numbers of nodes having high degree of neighboring nodes introduce themselves to the network called CH candidates. Then their residual energy is calculated but for selecting CH priority, it is given to the node having high degree. In SEECH one more candidate is selected called relay used to transmit data from CH to the BS [4].

4. Energy Model

The energy model used in all the techniques is same. This model used to calculate the amount of energy consumed for transferring the data from simple node to CH, from CH to intermediate CH, from CH to BS and also from node to BS. The radio dissipation energy model consists of transmitter having transmit electronics (E_{elec}) which depends upon factors like coding, modulation, filtering and transmit the signal and amplifier depends on the distance to the receiver and the tolerable bit-error rate

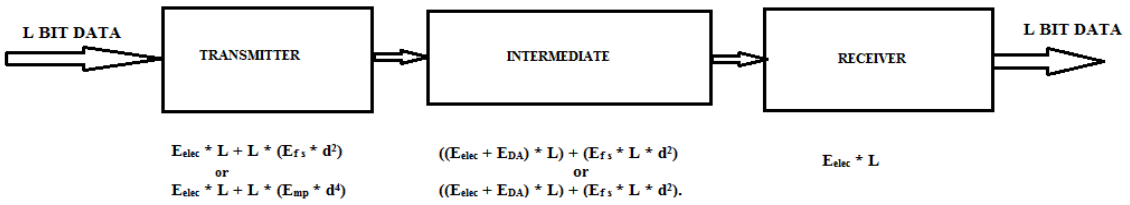

Fig. 4. Radio Energy Dissipation Model

If the distance between transmitter and receiver is less than threshold distance (say d_o) then free space (d^2 power loss) channel model used and if distance between transmitter and receiver is greater than threshold distance (say d_o) then multi path fading (d^4 power loss) channel model used [5].

The energy consumed by the specific nodes/CH for transmitting k bits of data is:

Energy consumed by transmitter (for $d<d_o$)

$$E_{tx}(L, d) = E_{elec} * L + L * (E_{fs} * d^2) \quad (9)$$

Transmission energy for intermediate node

$$E_{tx}(L, d) = ((E_{elec} + E_{DA}) * L) + (E_{fs} * L * d^2). \quad (10)$$

Energy consumed by transmitter (for $d \geq d_o$)

$$E_{tx}(L, d) = E_{elec} * L + L * (E_{mp} * d^4) \quad (11)$$

Transmission energy for intermediate node

$$E_{tx}(L, d) = ((E_{elec} + E_{DA}) * L) + (E_{mp} * L * d^4) \quad (12)$$

Energy consumed by Receiver

$$E_{rx}(L) = E_{elec} * L \quad (13)$$

Table I. Radio Parameters

Parameters	Operation	Values
Transmitter / Receiver Electronics	E_{elec}	50 nJ/bit
Transmit amplifier (if d to BS<do)	E_{fs}	10 pJ/bit/4m^2
Transmit amplifier (if d to BS>do)	E_{mp}	0.0013 pJ/bit/m^4
Data aggregation energy	E_{DA}	5 nJ/bit/signal

Table I contains first order radio model parameter used to calculate the energy consumed by each node in a cluster at various distances.

III. RESULTS

Table II. Comparative Results

Protocol	DR	DDR	IDDR	SEECH
Lifetime	High	Low	Very High	Low
No. of CH	Dist. from centre point of Cluster	Dist. from centre point of Cluster	Residual energy	Degree of node and Residual energy
Load Balancing	Medium	Good	Very Good	Good
Clustering	Static	Static	Dynamic	Dynamic
Algorithm Complexity	Low	Low	Medium	High
Energy Efficiency	Medium	High	Very High	High

Table II consists of the comparative results of different protocols used to preserve the enery consumes in the nodes for data transmission. These comparative results are obtained from the papers of respected protocols.

IV. CONCLUSION AND FUTURE WORK

From last so many years, energy efficiency in WSN become an important parameter in research field so that the lifetime (time span between start of the network and the time when first node) of the nodes can be increased. In our paper we present the ideas of some recently developed protocols based on clustering and CH selection and compared them. All of them have the aim to enhance the lifetime of the nodes. These protocols especially IDDR show improvement as compared to the other protocols. To further enhance the parameters for high energy efficiency, we can combine or hybrid the best part of these protocols or develops new technique for energy enhancement in WSN.

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