Enriching the Energy Efficiency using Enhanced Virtual Grid Algorithm (EVGA) in Large Scale Wireless Sensor Network

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Abstract
Wireless sensor network is extensively worn to check the spot (or) region. Diminutive amount of nodes are deployed to sense, transmit the information. To augment the life span of nodes, different types of routing algorithm are used. Grid structure aids to get better lifetime of the network by partition the spot into number of grids. The proposed method helps to beat the issues to loss the energy at the time of transmitting the data from Sensor Nodes (SN) to Cluster Head (CH) and to the Base Station (BS). Virtual grid recital facilitates to boost the energy by energy consumption. It supports to broadcast the data quickly. BS carries out the entire task resembling cluster head selection, cluster formation, Grid formation and isolated node recognition etc. Each cell is divided into equal number of cells in grid and it allows to communicating the node for data transmission easily using shortest path algorithm. EVGA proves it increases the lifetime of the node and it consumes energy.

Keywords
Grid cell, Energy consumption, Hot spot Transmission range, Sensor nodes

I. INTRODUCTION

Wireless sensor networks deployed in many places to monitor the region. Lifetime of sensor node is major issue faced by the technology area. If the nodes are deployed, in some critical location it can't permit to transform the sensor node. If the battery level is downwards then it left its connection. In WSN, different types of protocols are used to amplify the energy of the node. LEACH is the basic protocol which helps to adapt the low energy node to transmit the data with the help of Cluster Head. Cluster and Cluster Head tries to avoid the energy drains quickly.

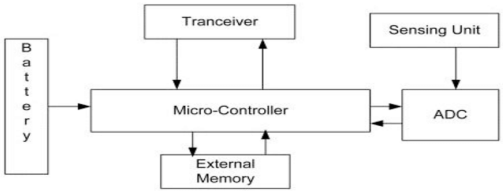


Fig 1. Sensor Node Architecture

In Fig 1 Sensor node architecture demonstrate the parts in each node, Each sensor node is made up of Radio, Battery, Micro controller, sensor interface, analog circuit, Memory. To increase the energy efficiency cluster formation and grid computing methods are used. Cluster helps to increase energy efficiency but in some cluster methods it faces the issues like Reclustering, Hot spot, Transmission delay, Data Congestion, Long distance communication etc.

Reclustering : Elect a cluster Head at regular intervals.

Hot spot issue : Sensor nodes which near to sink drain its energy faster.

Delay : In cluster based approach each sensor node send a data to the CH, then passes the information to the BS via Sink node. CH accepts more information from the SN, there is no way to transmit the data quickly to the BS. Sometimes it arise delay.

Data Congestion: Sink node receives the data from the CH and passes the information to the BS, Sink take delivery of more data from CH endlessly. Data may collapse and congested.

Long distance communication: If the node is declared as isolated then it may communicate with the Multihop communication. Sometimes isolated node can't be in touch with BS.

These are some of the problem faced by the Cluster technologies. Some researchers introduced the concept of Grid based approach to conquer the struggle and increase the energy efficiency and reduce the consumption. This paper proposes the EVGA to partition the location into number of grid cells. Cluster is formed inside the grid region and the cluster contains Cluster Head to collect the data and transmit the data to the BS. Obviously it reduces the data traffic to increase the energy. Death of the nodes diminished due to nonexistence of long distance announcement. The remaining section of this paper is ordered as follows: sections II depict EVGA and its features, Section III defines the experimental analysis, and section IV concludes the algorithm.

Main benefits of grid routing as follows:
1. Virtual grid structure is formed depends upon the location. It helps to identify the nodes location easily.
2. Easy to transmit the data to the BS. It helps to avoid data congestion and consumes energy.

II. RELATED WORKS

In WSN, Grid Computing helps to reduce the energy consumption and it ropes to upsurge the energy efficiency. Very limited protocols are used to raise the energy for sensor node in WSN. Some of the protocols are listed below.

1.Grid routing: an energy-efficient routing protocol for WSNs with single mobile sink

In this protocol, CH are placed at the centre location. Each cell has a Cell header (CH) and it can interconnect through the gate way nodes. Number of cell header is increased.

Mobile sink is used to accumulate the data from the CH, If CH meets the threshold value. The existing CH elect the next CH is contingent upon scheming like residual energy and distances. It permits to interconnect the node shortly. But it not reinforced to communicate the data quickly and sink node collect the data occasionally it may raise data loss. It may increase the energy consumption.

2. Improving Lifetime of Wireless Sensor Network Based on Sinks Mobility and Clustering Routing

Regarding the result of this paper, network location is separated as hexagonal and makes the equal cluster based on the radius. If radius is increased then automatically diameter of the location is also increased. Sink nodes are used to collect the data. Direction of the mobile sink is fixed and it allows moving in two directions. It may pass the data quickly through sink node but it increases the energy consumption and efficiency. It supports to perform in small scale network area.

II. PROPOSED WORKS

Enhanced Virtual Grid Algorithm (EVGA)

Grid is the concept which supports to increase the energy efficiency and consumption in WSN. Grid technology is used in incredible application to monitor and sensing the information. It provides trouble-free way to communicate the node from one spot to another. While using these tools it makes the region under the control at all time. Virtual Grid is the enhanced method in grid technology. Virtual Grid is formed depends upon the region.

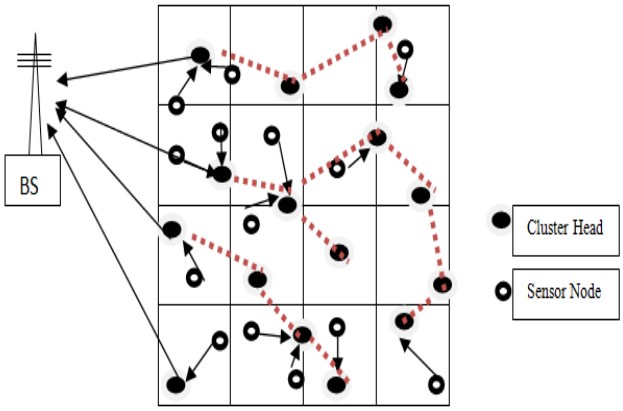


Fig 2. Grid Structure

In Fig 2. The Grid Structure partition the region into number of grid cell. Each grid cell has a Cluster Head (CH). This is the basic methodology to communicate the BS. CH receives the information from the Sensor Node (SN) and transmits the information to the BS. If CH lost its energy then it automatically raises the Reclustering technology to elect the cluster head. LEACH is the basic protocol which assists to elect the CH randomly. Some of the CH is located at long distance from the BS then the CH communicates the nearest CH from the grid cell. K-nearest neighbour algorithm builds to prefer the nearest neighbour node to transmit the data from one grid cell to another.

$$k = \begin{Bmatrix} 0 > x < 250 & \frac{n}{n} \\ 250 > x < 500 & \frac{n}{2} \\ 500 > x < 1000 & \frac{n}{4} \end{Bmatrix} \qquad Equ\ (1)$$

In Equ 1, it defines the partition of the grid into number of blocks. Each block separated by equal number of size. The proposed algorithm EVGA (Enhanced Virtual Grid Algorithm) is little different than the normal grid technology concept. In EVGA, network region is divided into number of grid cell depends upon the sensor node range. For example node has the range of 250mm then the grid cell size is (250,250) it construct the transmission easily between the nodes.

0,0

Fig 3. Network size 250*250

In Fig 3. Network size is 250*250 then there is no need to partition the cells since the range of the sensor node can communicate the BS easily.

0,0	0,1
1,0	1,1

Fig 4. Network size 500*500

In Fig 4. Network size is 500*500 then the location area is divided into grid cell. Each grid cell is formed by the range of 250.

0,0	0,1	0,2	0,3
1,0	1,1	1,2	1,3
2,0	2,1	2,2	2,3
3,0	3,1	3,2	3,3

Fig 5. Network size 1000*1000

In Fig 5. Network size is 1000* 1000, network location area is divided into 4 rows and 4 columns. Each row has the range 250 equally each column has the range 250. It agrees to transmit the data from one location to another rapidly. It increases the data transmission and stay away from the delay and it consumes less energy.

if size of the network is augmented, BS automatically forms the grid cell and allows the communication to increase energy efficiency and reduces the energy consumption. In this algorithm, EVGA supports to partition the grid in the basis of the method which compute and generate a path to arrive at the BS quickly for data transmission. BS partitions the grid and allocates the grid cells. After partitioning the network size BS allows the nearby nodes to exchange data directly (single hop communication). Communication range is greater than 250mm then CH is chosen for each grid cell to take

delivery of the information from the SN. If suppose the node is not located in the range 250mm then the node is defined as isolated node. Isolated node can communicate through the nearby node and send out the data through that node.

$$k = \sqrt{\frac{2R}{4}} \qquad Equ\ (2)$$

In Equ 2, it calculates the range of sensor node and separate the grid depends upon the range. Each network location size is separated by four sections. Sink node receives the information from the isolated node and CH.

K <250 ➔ SN→ BS (Single hop)
K > 250 and K < 500 ➔ SN→CH→ BS (multihop) Equ (3)
K > 500 and K < 1000 ➔ SN → CH → Sink → nearby node →BS

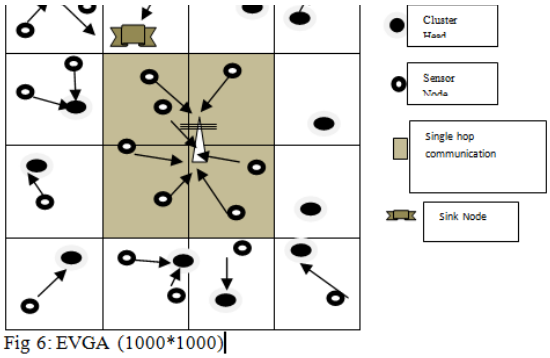


Fig 6: EVGA (1000*1000)

In Fig 6: 1000*1000 network size is detachment into 4 rows and 4 columns. Each row and column size is fixed as 250. Sink node is located to obtain the data from the CH. Sink node navigated from the one grid cell to another easily. Partition the location into number of grid cell will avoid the isolated node. The node is located at the position which is far from the BS, especially the node not able to converse the nearby node is known as isolated node. Using this algorithm it avoids the isolated node and it makes easy to communicate between the nodes. 250mm range is fixed for each cell; it can communicate the CH easily. Network Location size is increased then it uses the sink for the next location. If size of the Gird is increased, it allots the highest energy node as sink node to receive the data from the CH. Sink2 can communicate the Sink1 to transmit the data.

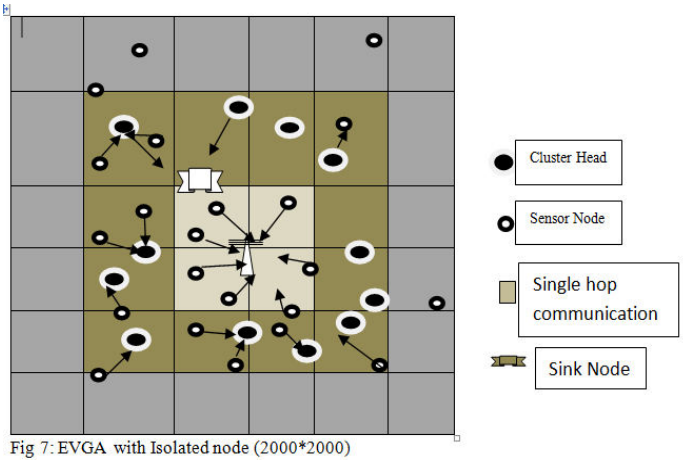


Fig 7: EVGA with Isolated node (2000*2000)

In Fig 7: Network location size is 2000*2000, Some isolation nodes are located in the area. If Network area is increased then the node can find out the shortest path between the nodes to communicate from the location. Some of the nodes identified as isolated node, if the node is isolated then that node communicate the nearby cluster and elect the CH based on the residual energy. CH receives the information from the nodes and passes the information to the nearby CH in inner round, it is known as multihop communication.

K-Nearest Neighbour (KNN) algorithm provides the provisions to find out the nearby node which helps to communicate the BS quickly. If K = 1, then the case is purely allotted to the class of its nearest neighbor. Using Euclidean distance calculation find out the distance of the node.

$$d(p,q) = \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2} \qquad \text{Equ (4)}$$

In Equ 4, Euclidean distance formula is used tocalculate the distance between the nodes. P and q are Euclidean space, qi and pi are defined as vector points, n defines n-space.

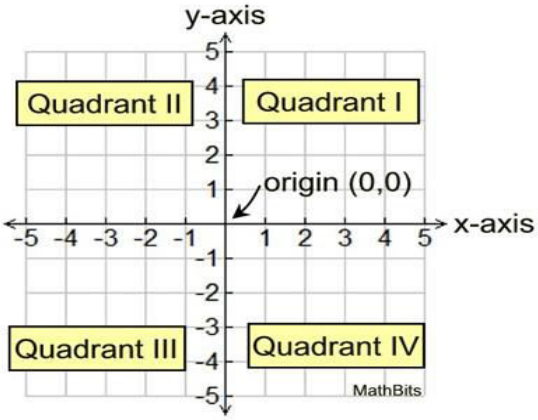


Fig 8 : Grid Partition with Quadrants

Algorithm For Grid Partition

1) If Size(loc)=250 then
   i) Size(gridcell)=250
2) If Size(loc)=500 then
   i) Size(loc)>range(SN)
   ii) Cell(S)=Size(loc)/2
3) If Size(loc)=1000 then
   i) Size(loc)>range(SN)
   ii) Cell(s)=Size(loc)/4
4) If Size(loc)=2000 then
   i) Size(loc)>range(SN)
   ii) Cell(s)=Size(loc)/4
   iii) If cell(s)>250 then
      (a) Siz=size(loc)/1000
      (b) Cell(in)=cell(s)/siz

Alg 1: For Grid Partition

In Alg 1: size of the location is verified every time to partition the grid into number of cells. If size of the location is increased then the location area is divided into four segments and multiplies of 1000 divides the size to fix the location size into 250 because range of SN is fixed as 250.

3.1 Simulation Parameters

The experimental analysis is done with certain parameters. In Table 1. Various parameters are denoted for the experiment. This parameter helps to improve the energy efficiency and consumption depends upon the location or need the parameters may change. A set of parameters are mentioned below for the experimental analysis to increase the energy efficiency, reduce the energy consumption, and avoid delay to transmit the data from the information, it also support to increase the packet delivery ratio.

Table 1. Parameter Settings

Width of the Network	1000m
Height of the Network	1000m
No.of Nodes	50 to 250
BS Location(x,y)	500,500
Initial Energy	100J
Energy consumption for sleeping	0J
Simulation Time	40ms
Data packet Size	500 bytes
Bandwidth	1Mbps
Communication Range	250mm

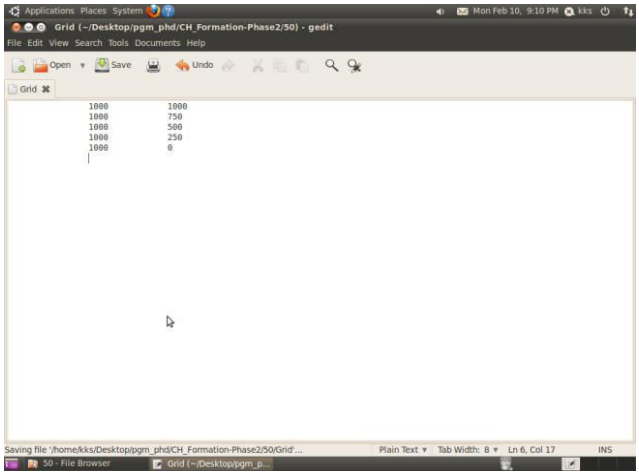


Fig 8: Grid cell Separation

In Fig 8. Network size 1000*1000 is divided into number of segments like 250, 500, 750, 1000. Each cell is divided into size (250) because of the sensor node range. It assists to communicate the nearby cell easily. Ad hoc On-Demand Distance Vector (AODV) Routing allow communicating the node basis of on demand. If the node not able to communicate the CH. AODV Routing supports to create a path between the SN and the isolated node.

3.2 Performance Evaluation

1. Network location is divided into number of grids
   Based upon the area.
2. //BS create an array and elect the CH
3. For each SN in network
4. If(rem.ener(SN)>Th value then
5. BS_arr[i]=SN[i]
6. Exit for
7. SN← BS(BS send the information about the CH and CM to all the nodes)
8. If range(SN)<250 then
9. BS← SN
10. Else if range(SN)>250 and range(SN)<500 then
11. BS← CH ← SN
12. Else if range(SN)>500 and range(SN)<750 then
13. BS← CH ← SINK← SN
14. Else
    //Node identified as Isolated
    //Checks the nearby node to transmit the data
    //Using AODV it identifies the nearby node and transmit the data
    Otherwise sink receive the information.
15. Endif
    //Based upon the location size.
    Algorithm Sink node introduced to collect the data in each range.

Alg 2: Node communication and allotment

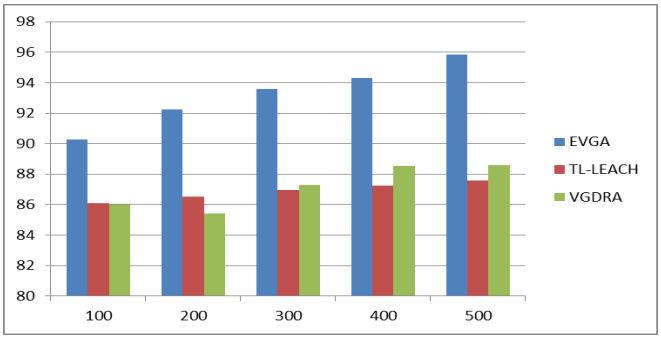
In this experiment, 1000*1000m2network location is used and nodes are deployed randomly. In Alg2. It describes the CH selection and communication range. It explores the BS work and Sink activities to gather the information. Energy Efficiency and Energy consumption plays a major role in WSN. EVGA improves the lifetime of the network. EVGA is compared with TL-LEACH to find out the performance examination of the algorithms.

III. EXPERIMENTAL ANALYSIS

3.3 Result And Discussions

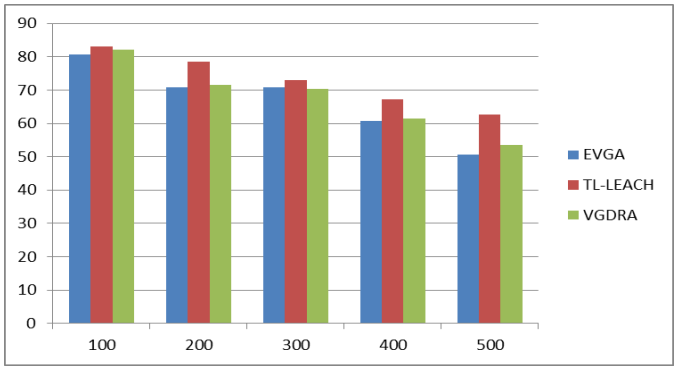
3.3.1 Energy Efficiency

Network size is separated with equal grids and allows transmitting the data using cluster Head. Throughout this examination EVGA compared with TL-LEACH and VGDRA. The proposed tactic shows the best result to increase the energy efficiency of the SN than VGDRA and TL-LEACH. VGDRA supports to transmit the data without delay using sink node. It receives the data and pass the gathered to BS. Nodes transmit the data quickly to base station while the distance is less. If distance increased sink node takes time to transmit the data.



3.3.2 Energy Consumption in WSN

When compared EVGA with TL-LEACH and VGDRA, Both the protocols consumes more energy to transmit the data. VGDRA consumes less energy while the number of nodes is decreased. If the number of nodes increased it consumes more energy .EVGA reduces the energy consumption to transmit the data and allows selecting the best path to connect the nodes to reach the base station easily. It reduces the energy consumption even the number of nodes increased. It mainly supports for large scale network.



Comparison analysis between EVGA, VGDRA and TL-LEACH

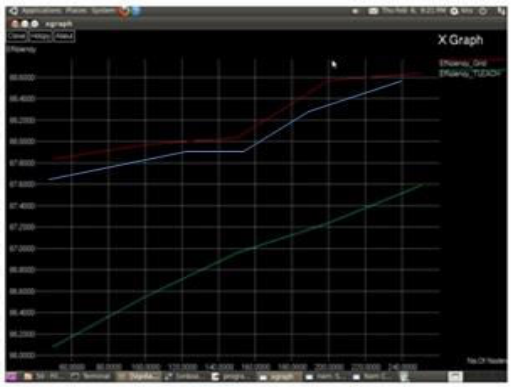


Fig 9: Energy Efficiency

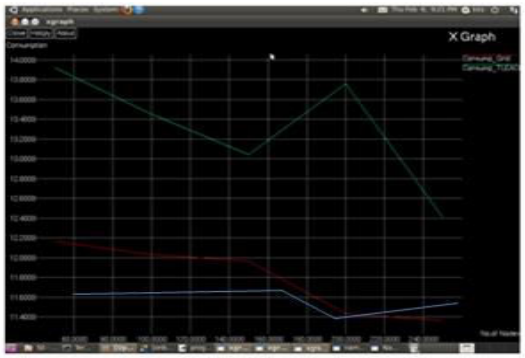


Fig 10: Energy Consumption

In the comparison analysis,Fig9, shows the energy efficiency of EVGA and Fig10, shows the energy consumption of EVGA. EVGA improves the Energy efficiency and PDR. Grid method supports to decreases the Energy consumption and it increases the energy efficiency. EVGA consumes less energy to transmit the data. It avoids the long distance communication. Sink node is used to collect the information from the CH and isolated node. Thoroughgoing it avoids the isolation of the nodes because the range is fixed with 250mm mostly all the nodes can easily communicate the nearby nodes. Depends upon availability sink node will used and the network size parameters may change and it transmit the information based on the algorithm.

IV Conclusion

In this paper we introduced the algorithm Enhanced Virtual Grid Algorithm (EVGA) which increases the energy efficiency and packet delivery ratio when compared with the protocols TL-LEACH, VGDRA. At the time of comparison VGDRA shows better result than TL-LEACH. EVGA consumes less energy and it avoids the delay to transmit the information from the SN to CH and to BS. On the other hand we try to introduce this algorithm in very large scale network. It increases the lifetime of SN. Moreover we planned to implement the concept with IOT environment, to transmit the data and refresh its memory automatically. IPV6, and Zone routing protocol may use to improve this EVGA to improve the Lifetime of network.

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