Materials Today: Proceedings 45 (2021) 2599–2602

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Energy efficient distance based clustering protocol for heterogeneous wireless sensor networks

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ARTICLE INFO

Article history:
Received 23 October 2020
Received in revised form 8 November 2020
Accepted 11 November 2020
Available online 31 December 2020

Keywords:
EERP (Energy Efficient Routing Protocol)
PEGASIS (Power-Efficient Gathering in Sensor)

ABSTRACT

Wireless Sensor nodes are considered for range of applications such as temperature, humidity monitoring and etc. Sensor nodes are finished up of non-replaceable battery power, limited memory and processing capabilities. So the life span of the sensor node and network depends on the energy utilization. As the deployment area is not reasonable for manual intercession, energy spending is crucial to enhance the existence of the network. Many Authors have proposed many routing protocols to operate the energy very efficiently. Clustering is one of main technique to condense the energy consumption in the network. Selecting Cluster head is the major process for energy efficiency of clustering algorithms. As maximum energy is dissipated during data transfer, communication within the cluster is paramount. Communication distance between the Cluster head and member node is paramount. Node with elevated communication distance within the Cluster will acquire more energy. So the proposed protocol reduces the communication distance between in the cluster to condense the energy burning up in the network and recover the lifetime of the network.

Selection and peer-review under responsibility of the scientific committee of the International Conference on Advances in Materials Research – 2019.

1. Introduction

Wireless sensor network (WSN) is a prime element of the everywhere computing. Group of nodes are communicated with each other to forward the data between the node to sink is called wireless sensor network. As the better network and wireless technologies, different applications are ending such as tracking, monitoring of ecological condition etc. [5-9]. Enhancing the hardware design can advance the energy efficiency of the network. Further to that, it is possible to improve the performance of the communication protocol to improve energy efficiency of WSN [1-3]. The most of the energy is utilized during the communication. Selection of Cluster Head provides the efficient communication that limits the energy utilization [10,12]. This article proposed an efficient clustering architecture for the heterogeneous WSN with the contemplation of Distance and the Energy.

2. Related work

A WSN is constructed by thousands of nodes that are deployed at random in the circulated manner [4,14,15]. We presented an analysis of clustering algorithms for WSN. The Proposed SEP (Stable Election Protocol) [13] is considered for hierarchical HWSN. Here the author considers advance nodes and the normal nodes. In this protocol the CH selection is based on probability energy of nodes. The DEEC (Distributed Energy-Efficient Clustering) [11] is proposed for multi-level HWSN. The CH selection is based on residual energy and average network energy. Furthermore DEEC achieved better life time compared to SEP.

3. Proposed work

3.1. Proposed algorithm

In this article, an efficient Clustering architecture is projected for HWSN. Main purpose of this algorithm is to reduce the energy efficiency in terms of intra cluster communication. The distance is

https://doi.org/10.1016/j.matpr.2020.11.339
2214-7853/
Selection and peer-review under responsibility of the scientific committee of the International Conference on Advances in Materials Research – 2019.

most important in the wireless communication where the longer distance need more power dissipation than the shorter distance. So among the distributed nodes deployed in the field, CH location among the nodes makes the energy efficient communication between the nodes. In this proposal, the area is divided into 4 equal partitions (Quad Zone). Once the area is divided, the Cluster head selection will be done for each zone separately by Cluster head selection mechanism. In a zone, our consideration is to select the Cluster head which is very near to center area of the zone so all the member nodes belongs to this zone can able to make effective communication. The WSN is divided into 4 Equal Zones as shown in Fig. 1. The cluster head election process is given away by Fig. 2.

3.2. Network model

In this work, below mentioned the, assumptions are measured,

- Heterogeneous nodes
- Nodes to be considered as stationary
- Nodes are considered as die only energy is exhausted.
- All nodes have to send the data.

3.3. Energy model

Energy model for sending m bit packet over the distance d to the destination, Equation 1&3 represents the Transmission energy and Equation 4 shows the procedure to measure residual energy of sensor node.

$$Etx(m,d) = Etxelec(m) + Etxamp(m,d) \tag{1}$$

$$f(x) = \begin{cases} m \times Eelec + (m \times Efs \times d^2), d < d0 \\ m \times Eelec + (m \times Eamp \times d^4), d \geq d0 \end{cases} \tag{2}$$

Receiving message energy consumption is given by [14]

$$Etx(m) = m \times Eelec \tag{3}$$

3.4. Residual energy calculation

Residual Energy can be calculated by using equation (1) and (3)

$$Eres = Ein - (Etx(m,d) + Erx(m)) \tag{4}$$

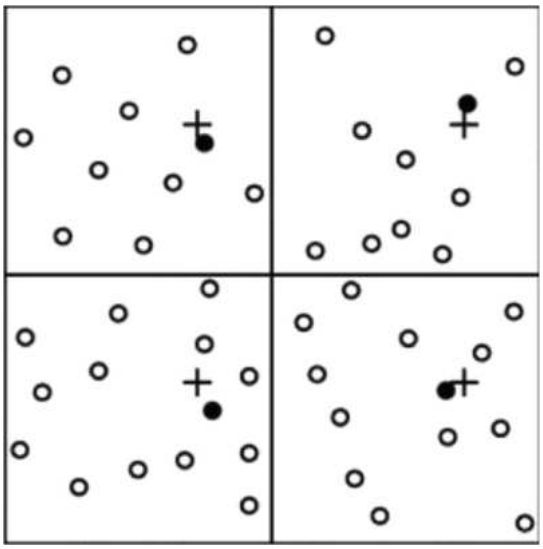

Fig 1. Partition of network area.

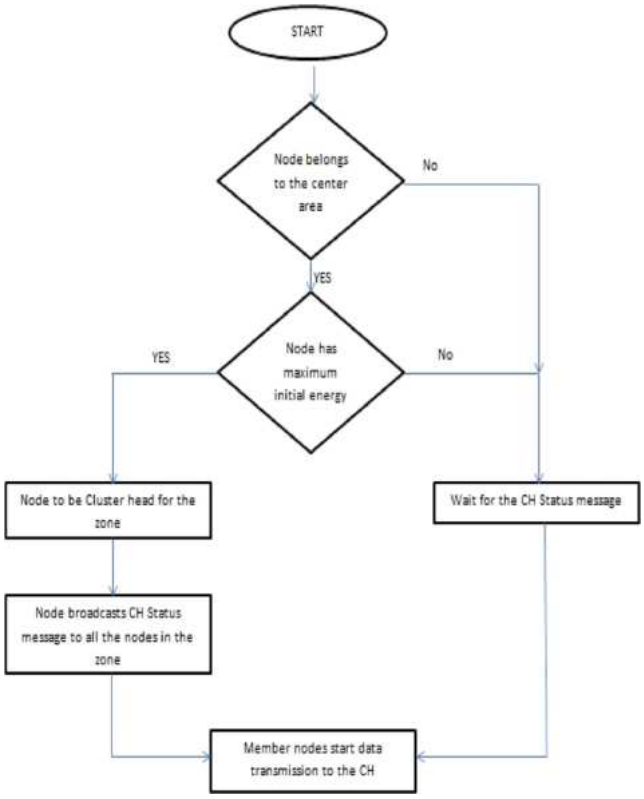

Fig 2. Cluster head selection process.

E_{in} = Initial energy of Sensor nodes.

3.5. Distance calculation

For finding the Center coordinates of the Square model, we need to find intersection point of the two diagonals. Its given by Fig. 3. Length of the diagonal is the distance between the two opposite sides such A to C or B to D as the diagonals are congruent.

Length of the side can be calculated by

$$X = \sqrt{(X3 - X1)^2 + (Y3 - Y1)^2} \tag{5}$$

$$Length\ of\ Diagonal = 2\sqrt{(X)} \tag{6}$$

By using the midpoint formula, we can find the mid-point location coordinates,

$$X = \left\{ \frac{X1 + X2}{2}, \frac{Y1 + Y2}{2} \right\} \tag{7}$$

From the above formula, we can find distance of two diagonals and also intersection of two diagonals to find the center coordinates of the Square model

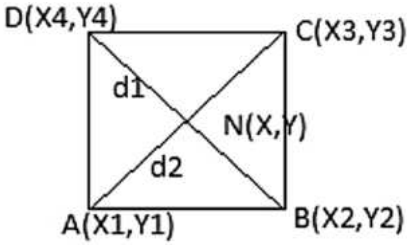

Fig 3. Square model in 2D.

4. Simulation result

The projected Energy Efficient Clustering Protocol is simulated using Network Simulator. The performance of the proposed protocol is measured up with PEGASIS Protocol in terms of their PDR, average end - end delay and Energy Consumption. Here the entire network is divided in two segments. Formation of Cluster and CH Selection.

4.1. Cluster formation and Cluster head selection

Network is divided into four equal zones in the given 100*100 m^2 area. Cluster Head is selcted based on the node belongs to the near area of center co ordinates of the zone and maximum residual energy.

The performance of the proposed system is studied by measuring Following Quality of service parameters. The Fig. 4 shows the animation image of cluster formation process. Figs. 5, 6 and 7 have shown the simulation results of QoS parameters.

Packet delivery ratio (PDR)

The number of packets successfully received from the transmitter. The higher value of ratio provides better perfomance of the protocol. PDR is calculated for PEGASIS and Proposed protocol

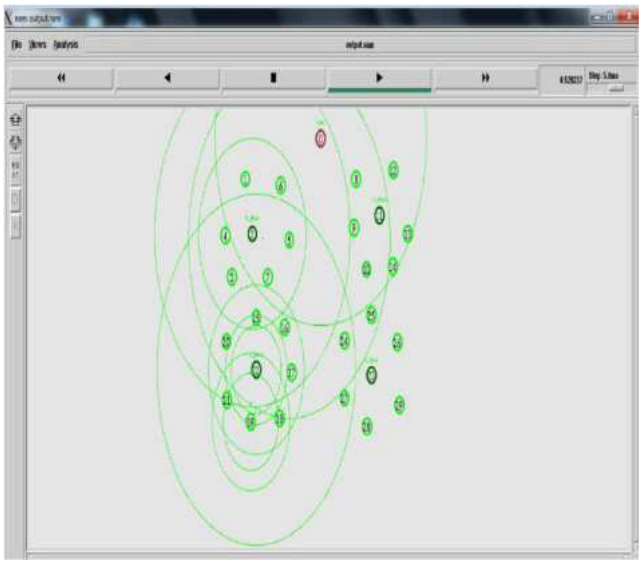

Fig 4. Cluster formation and cluster head selection.

Fig 5. Packet delivery ratio.

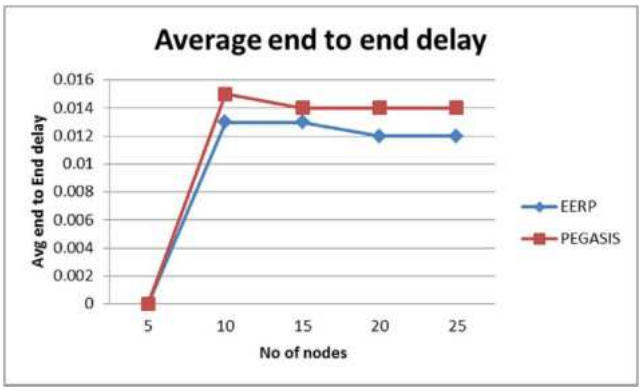

Fig 6. Average end to end delay.

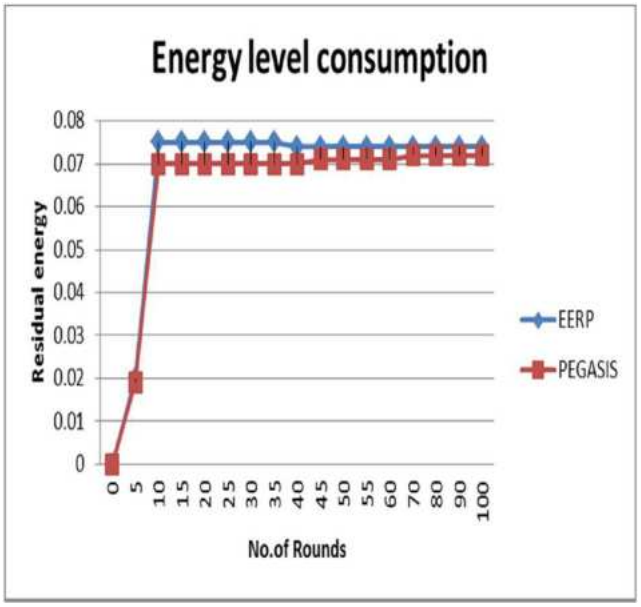

Fig 7. Energy level in terms of lifetime.

and it is clear that proposed protocol has higher ratio value in terms of the rounds for the lifetime

4.2. Average end to end delay

Number of pockets to reach the destination from the source.

It is clear from the graph that proposed protocol has delay time lesser than compared to PEGASIS protocol.

4.3. Lifetime in terms of energy level

Proposed protocol has high energy level than the compared protocol as from the below given graph.

5. Conclusion

Simulation result confirms that proposed method provides better performance in terms of lifetime, Energy efficiency and average end-end delay. This Energy efficient Routing Protocol improves lifetime of the wireless sensor network. In future work, Energy Efficient Clustering Algorithm will include the mobile nodes along with static nodes for lifetime improvement of heterogeneous wire-

less sensor network. The Performance of proposed protocol can be analysed by comparing with other clustering mechanism to maximize lifetime of WSN.

CRediT authorship contribution statement

M. Sheik Dawood: Conceptualization, Methodology. **S. Sakena Benazer:** Supervision, Software, Validation, Writing - review & editing. **S.K. Vijaya Saravanan:** Software, Data curation, Writing - review & editing. **V. Karthik:** Writing - original draft, Visualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Further Reading

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