Novel Scheme To Improve Lifetime of Wireless Sensor Networks

Sukhdev kumar
sukhdevk360@gmail.com
Sri Sai College of Engineering and Technology (SSCET)
Pathankot

Satyam Singh Dub
jeevanjot1999@gmail.com
Sri Sai College of Engineering and Technology (SSCET)
Pathankot

ABSTRACT - The wireless sensor network is the decentralized type of network in which sensor nodes can join or leave the network when they want. Due to small size and far deployment energy of the sensor devices is very limited. The energy hole problem exists in the network which affect performance in terms of certain parameters. In this research work, gateway nodes are deployed in the network which reduce chances of energy hole problem occurrences. The proposed and existing scenario's are implemented in MATLAB. The simulation results shows that proposed scenario is more efficient in terms of number of dead nodes and number of packets transmitted to base station.

Keywords - WSN, Clustering, Leader Nodes, Energy hole

I. INTRODUCTION

A network that is generated by combining various sensor nodes those interconnect and work with each other for monitoring the surrounding is known as WSN. There is a random deployment of the sensor nodes in such networks and they use wireless communications as a mode to communicate with one another. There are certain constraints faced by each sensor node in the aspect of limited energy, storage and processing potentials. These sensor nodes can damage physically in hazardous conditions. The architecture of sensor network may differ according to the demand of application. The data collection all across these networks is done by these nodes, which is then forwarded to the base station (BS).

It is hard to deploy large numbers of sensor nodes. This phenomenon generates more traffic. In order to minimize the complexity in communication process, a clustering algorithm is necessary. It is also required to deploy base stations in all clusters [1]. This process is known as cell splitting. The flexibility to control more traffic can be achieved by reducing cell size. Less communication overhead is provided by a cluster in the routing process. The groups of sensor nodes are created to form clusters using the clustering mechanism. Forwarding and aggregating the data are the tasks of each cluster head within the cluster. The data is then forwarded to the sink to be used as per the application.

The data aggregation process aims to collect and forward the important data across network. It helps in saving huge amount of energy in the overall network. It is an efficient method of saving limited resources in wireless sensor network. Collecting and forwarding the data efficiently with the aim of improving the life span of the network is the key objective of data aggregation algorithms [5]. This increases the difficulty for research developers concerned in development of systems. This frequently results in direct application to the network protocols.

1.1 GOALS OF DATA AGGREGATION

Following are the important objectives to be achieved by any data aggregation protocol:

1) Energy saving: The unnecessary or interrelated transmissions within a network are reduced by data aggregation. This phenomenon minimizes the power consumption for the overall network in direct manner. The architecture of data aggregation should consider energy saving prominently due to the energy limitation in wireless sensor networks.

2) Data accuracy: The accuracy between the recovered data and unprocessed data is known as data accuracy. Sensor nodes aggregate raw data into summarized form. This may result in the loss of some valuable data. This means that the recovered data at base station will be different from the raw data. Hence, energy saving with a satisfactory accuracy rate is a general requisite for many applications.

3) Network capacity saving: Sensor nodes have limited bandwidth. This limits the ability of wireless sensor network. Therefore, capacity saving should be examined regularly. Data aggregation has the ability to save network's capacity by delivering less number of packets to the base station. Therefore, it is required to consider network's saving capacity during the designing of an aggregation protocol.

1.2. ARCHITECTURE OF DATA AGGREGATION

The figure given below presents the general architecture of data aggregation algorithm in which the data that is sensed and collected by nodes is used. In the following step, the data aggregation is performed by using any of the centralized mechanism [6]. An optimum route is selected for transferring this aggregated data.

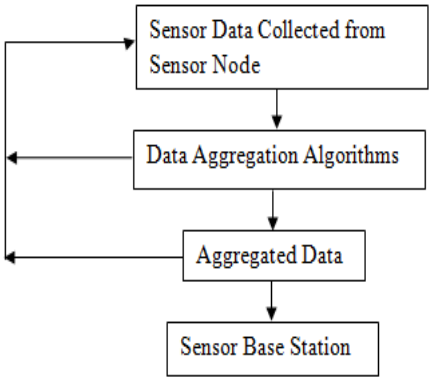

Fig 1.: Data aggregation algorithm's General Design

Some data aggregation techniques are described below:

a. Centralized Approach: Here, every node uses a multi-hop wireless protocol for the transmission of data across a direct route towards the central node. Packets are delivered to a leader that is a powerful node. Therefore, in an optimum case, the messages equal to the sum of external route lengths of each node are to be delivered in this method.

b. In-Network Aggregation: Using a multi-hop network for the collection and routing of data is called In-network aggregation. The main aim of this approach is to process data at intermediate nodes for reducing resource consumption particularly energy. This phenomenon extends the life span of the network. In-network aggregation includes two methods. These are with size reduction and without reducing the size. The method of merging & compressing data packets that reduces their size so that they can be forwarded to the base station is called with size reduction [7]. The nodes receive packets from their neighboring nodes. The process of combining data packets obtained from various neighboring nodes within one data packet is possible through this method which in addition does not process the data value by reducing the size of data packet.

c. Tree-Based Approach: To perform aggregation in networks, a tree is designed in the network through this method. This is a small span tree and the base station has its roots. The leaves are considered to the source nodes in this case. To forward the data across network, every node consists of a parent node. From the leaves to the base station, the data is transmitted across the network. At base station, parent nodes carry out aggregation.

d. Cluster-Based Approach: Here, clusters are generated by separating all the components of network and categorizing them into groups. To each of the cluster, a cluster head is assigned which is elected by the members of that cluster only. It acts as an aggregator and all the data that is collected by its members is forwarded to the sink present in the network.

II. LITERATURE REVIEW

Sneha Kamble, et.al (2016) proposed an energy efficient system for WSN. The proposed system used data gathering nodes to gather data from cluster head within the cluster [8]. The recommended system used VELCT (Velocity Energy efficient and Linkaware cluster Tree) for data aggregation at the data gathering node for decreasing overhead of the base station. This attack flexible system observed the data at the data gathering node. This system realized applicable or non-applicable information by observing data. The system detected the intruder having malevolent information in each cluster after recognizing unacceptable information. The proposed system restricted the information of the attacker and merely genuine information was delivered to the base station. A lot of tests were conducted on the recommended system. The tested results depicted that the recommended system efficiently conserved 83% of energy and consumed minimal energy in contrast to the earlier system. Moreover, the proposed system efficiently improved accuracy of data transmission and the network's performance.

Ekta Choudhari, et.al (2017) recommended an expansion for Iterative Filtering (IF) algorithms. For this purpose,

approximation was provided to make these algorithms collusion robust and rapidly converging [9]. The performance of the system with good potential had been improved by the expansion in the Iterative Filtering algorithm for its use in wireless sensor network. The stretching of IF (Iterative Filtering) algorithm was done with new technique to detect conspiracy & dropping. Early estimate of the aggregate values and the distribution of differences in all sensor readings were considered for this purpose. Biased and unbiased nodes had been utilized in this work for the testing of recommended approach. The tested results depicted that the suggested expansion in Iterative filtering minimized RMS along with detecting fault. In contrast to the available systems, the suggested system provided more satisfactory results. Making wireless sensor network more secure was the major objective of this work.

Jinhuan Zhang, et.al (2018) recommended a new ring based in-network data aggregation approach [10]. The proposed approach divided the whole network into rings. The data aggregation was performed ring by ring from exterior to interior. The source or intermediary aggregating node unicasted various aggregated packets for guarantying consistency in transmission. These packets were copied to its next hop node in the internal ring with the maximal remaining energy. The increase in unicast packet copies improved the reliability as well. The recommended approach adaptively unicasted various aggregated packets copies constantly in a window in accordance with the request transferring consistency and the imbalance of nodes' energy. The achieved analysis and simulation outcomes demonstrated the efficiency of the recommended approach.

Nihar Ranjan Roy, et.al (2019) recommended an energy efficient data aggregation approach for clustered WSN (EEDAC-WSN) [11]. The recommended approach allowed cluster member nodes for the delivery of small sized control frames for reducing transmission between clusters. Afterward, the cluster head node selected comparatively comprehensive frames from other nodes. The recommended approach could be combined with any clustering approach. In this work, this approach had been utilized with LEACH protocol for simulation purpose. The achieved outcomes were significant in terms of network steadiness period and life span. In this work, the effect of influential factors had been studied as well.

Shahinaz M. Al-Tabbakh, et.al (2017) recommended a new data aggregation based mechanism for WSN [12]. For sensing the priority and distributed properties, the heuristic tree configuration approach was designed which was known as the SDHEAT. On the basis of achieved simulation outcomes, a comprehensive analysis in terms of remaining energy, life span and end-to-end delay had been provided in this work. The proposed algorithm was compared with two heuristic data aggregation algorithms in WSN. The first algorithm was used as a source based tree aggregation while the second algorithm was used as a free topology aggregation algorithm.

Navjot Kumar, et.al (2016) proposed a new approach in which the data aggregation methods were used along with DACA [13]. This algorithm ensured enhancement in WSN in terms of various performance measures. The flaws identified during study had been removed by another clustering approach that is applied commonly in the heterogeneous node of network. These issues were related to non-coverage area and route creation. The proposed approach had the ability to improve system throughout. In contrast to traditional distance based clustering algorithm, the recommended algorithm could increase the life span of the WSN more efficiently.

III. PROBLEM FORMULATION

The network that is deployed by placing numerous sensor nodes across a region and does not include any centralized mechanism is known as WSN. The sensor network has the major issue of energy consumption which affects its reliability. An energy efficient mechanism used in WSN is clustering. The cluster head to normal ratio (CTNR) is introduced in the base paper to increase lifetime of wireless sensor networks. In the CTNR protocol, the cluster heads are selected on the basis of two parameters which are distance and lingering energy. The lingering energy parameter helps of select the cluster head dynamically in the network after each round. In the CTNR protocol, the energy hole is the major problem which reduces its efficiency. In this research work, CTNR protocol will be further improved to solve energy hole problem in WSNs.

IV. RESEARCH METHODOLOGY

This research work is based on to resolve energy hole problem in wireless sensor networks. The proposed architecture is divided into three phases which are selection of cluster head,

leader node selection and gateway node selection for the data aggregation.

1. **Selection of Cluster Head:-** In this phase, whole network will be divided into clusters based on location based clustering. The cluster heads are selected in each cluster based on lingering energy and distance. The sensor node which has maximum lingering energy and minimum distance to base station will be selected as the cluster head. All the nodes which are in the cluster will aggregate data to cluster head. The cluster heads are responsible for the further data transmission. The cluster heads are selected using equation number 1

$$R_{CH} = R_{min} * [1 + \left(\frac{d_{BS} - d_{BSmin}}{d_{BSmax} - d_{BSmin}}\right)] \quad (1)$$

In the given equation R_{min} is the radius of the cluster, d_{BS} is the node distance from the base station, d_{BSmin} is the minimum distance from the base station, d_{BSmax} is the maximum distance from the base station.

2. **Selection of Leader Nodes:-** The leader nodes are the nodes of the second phase. The leader nodes are those which are not selected as the cluster head but are eligible to be selected as cluster head. The sensor nodes which have maximum lingering energy but not least distance to base station are selected as leader nodes. The leader node selection is defined which the equation 2

$$F_{LN-value} = \eta * M_{deg} + \frac{\lambda}{K_{LN}} \quad (2)$$

3. **Selection of Gateway Nodes**:- The selection of gateway nodes is the third and last phase of the methodology. In this phase, the nodes which are not selected as leader and cluster head are eligible to be selected as gateway nodes. The gateway nodes are selected based on the distance. The Euclidian distance is calculated from base station to all nodes in the network which are eligible to be selected as gateway nodes. The nodes which have least distance to base station are selected as the gateway nodes in the network. The sensor nodes sense information and transmit that information to cluster head. The cluster heads transmit information to leader nodes which later transmit information to gateway nodes. The gateway nodes are in direct contact to base station. The base station receives information from gateway nodes. The complete flowchart is described in figure 2

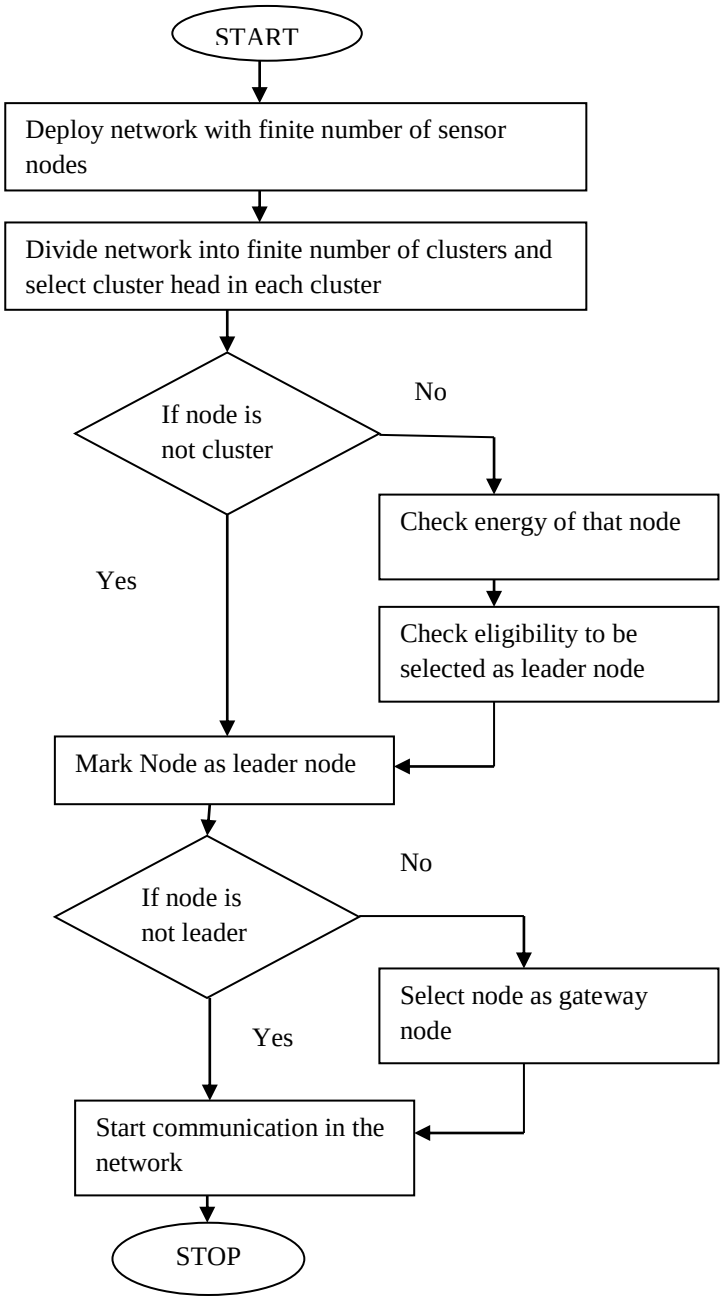

Fig 2: Proposed Methodology

V. RESULT AND DISCUSSION

In this research work, the proposed methodology and existing methodology are implemented for the data aggregation. In the proposed methodology, the gateway nodes are deployed near to base station which solve problem of energy hole from the network. In the existing methodology, the gateway nodes are not deployed which raise the problem of energy hole in the

network. The simulation is performed in the network based on the simulation parameters described in the table 1

Table 1: Simulation Parameters

Parameters	Values
Number of nodes	50
Initial Energy	0.5 joules
Area	800 * 800 meters
Antenna type	Omi directional
Queue type	Priority queue
Queue length	50
Transmission medium	Wireless medium

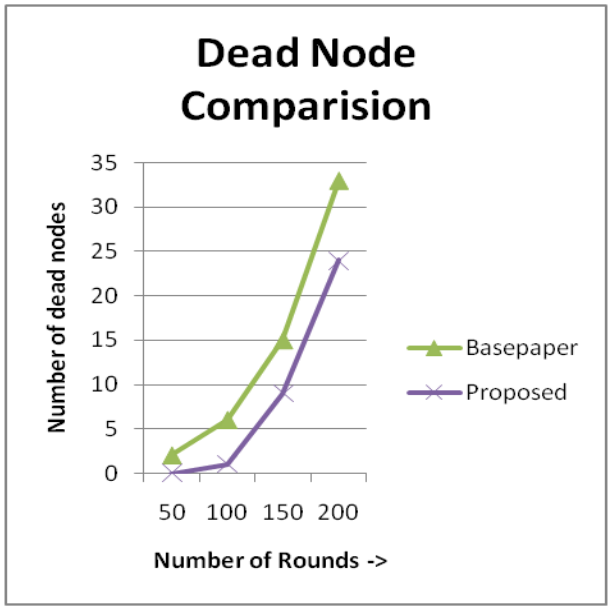

Fig 3: Dead Node Comparison

As shown in figure 3, the number of dead nodes is compared between the existing and proposed techniques. In the existing scenario, energy hole problem exists due to which number of dead nodes are high and in the proposed scenario energy hole get solved which reduced number of dead nodes

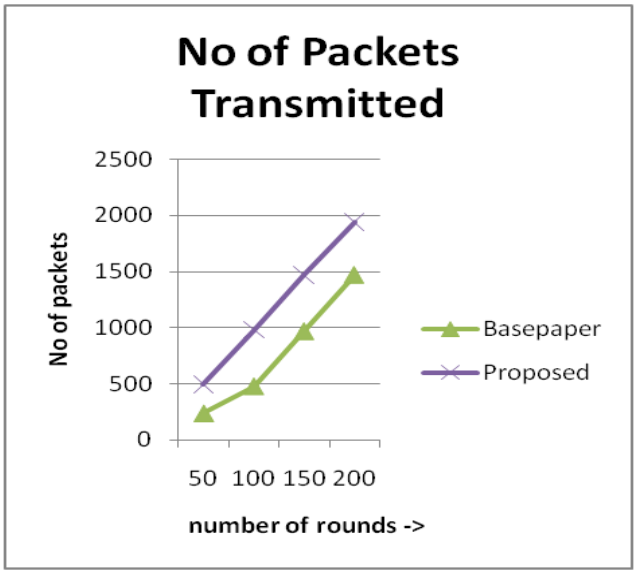

Fig 4: Number of packets transmitted

As shown in figure 4, the proposed scenario and existing scenario are implemented in terms of number of packets transmitted. It is analyzed that more number of packets are transmitted in the proposed scenario as compared to existing scenario.

VI. CONCLUSION

In this work, it is concluded that energy hole is the problem which exists in wireless sensor networks. The energy hole problem affect network performance in terms of certain parameters like energy consumption of the network. In this research work, the energy hole problem get solved from the network using gateway nodes. The gateway nodes forward the data which is taken from the leader nodes. Due to data transmitted by the gateway nodes energy is not depleted at steady rate. The simulation results show that number of dead nodes is less in proposed scenario as compared to existing scenario. In future, security of the network can be improved to increase efficiency of the network

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