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Research Article

A combined adaptive data aggregation and hierarchal routing (ADA-HR) protocol to improve the QoS and lifetime of WSN

Nagesh.R[1] ,

[1] Research Scholar,
Centre for PG Studies Muddenahalli,
VTU, Karnataka, India
nagesh.rajudvg@gmail.com

Dr.Sarika Raga[2],

[2] Associate Professor, Dept
of DECS, Centre for PG Studies,
Bangalore Region, VTU
VTU. Karnataka, India
raga.sarika@gmail.com

Abstract

Wireless sensor networks have attained immense attraction in the field of research, academia and industrial applications due to their significant use in data collection. These networks are powered by batteries which have limited power resources and these batteries cannot be replaced, hence, maintaining a fair network lifetime is a challenging task in it. Moreover, improving the packet delivery performance is also an important task of QoS. Currently, hierarchal routing schemes have been proven to enhance the efficiency in packet delivery transmission and improving the network lifetime. However, existing routing schemes suffer from various challenging issues. In this work, we introduced a combined approach of data aggregation and hierarchal routing. The proposed data aggregation scheme uses average function to aggregate the data in different time slots whereas proposed routing scheme introduces a new clustering approach which considers data aggregation energy consumption also to select the cluster head. Moreover, a weighting function is also derived which helps to identify the next hop for data transmission. The comparative analysis shows the proposed approach achieves better performance in terms of network lifetime, end-to -end delay, and throughput.

Keywords - Energy aware routing, hierarchal routing, data aggregation, QoS, clustering

1. INTRODUCTION

Currently, the demand of real-time data collection and processing system has increased due to emerging applications in daily life scenario. In this field of real-time data processing, the wireless sensor networks (WSNs) have emerged as a promising research topic for research community, academia, as well as industrial applications. The WSNs are extensively adopted in various fields such as monitoring the environmental conditions, healthcare applications, and military applications [1]. The WSNs are consist of large number of sensor nodes which are spatially distributed to monitor the applications specific condition as mentioned before. These sensor nodes collect the information by sensing the environment and transmitting it to the desired destination using hop-by-hop communication strategy. Generally, the sensor nodes are equipped with the limited power and memory resources due to the reason that the senor nodes batteries are non-rechargeable and non-changeable [2]. Moreover, these networks are installed in harsh and unattended environment where it is difficult to maintain the network.

Due to these issues, the energy consumption minimization becomes the prime task for research community to improve the network lifetime [3].

Energy-aware routing schemes play major role in improving the network lifetime. Direct transmission of data from node to base station consumes more energy. Mainly, the energy aware routing schemes are categorized into two categories as flat routing and hierarchical routing [4]. In flat routing, each node has capability to collect, process and transmit the data whereas in hierarchical, nodes are arranged in a hierarchal manner according to their capacity of data processing. Several studies have reported that the hierarchal routing achieves better performance, in terms of, improved network lifetime. According to this concept, the sensor nodes transmit the collected data to their corresponding cluster head (CH) which subsequently, forwards the data to the base station or a neighboring cluster head for further processing. Hence, clustering based schemes are widely adopted in this field. Several energy-aware routing schemes have been presented which are based on the cluster and cluster head formulation methods.

1.1. Clustering based routing protocols

Clustering plays important role to improve the network performance. Several researches have been carried out based on node clustering mechanism such as TEEN, Stable Election Protocol (SEP), Hybrid Energy Efficient Distributed Computing (HEED) Protocol, Distributed Energy Efficient Clustering (DEEC) Algorithm, Low Energy Adaptive Cluster Hierarchical (LEACH) and improved LEACH. TEEN routing protocol is the widely adopted hierarchal routing protocol. According to this protocol, a sensor node communicates with the base station only if a sudden change occurs in the monitoring area. Also, it follows the single-hop communication to establish the communication between sensor node and cluster heads (CHs) [5]. In SEP protocol, the nodes are classified as “normal” and “advanced” nodes. The advanced node is selected as cluster head and normal node is treated as relay node or cluster member node. In HEED protocol, CH is chosen depending on the amount of energy left over and node density. In DEEC protocol, multiple energy level solution is considered as the main parameter for cluster head selection. In LEACH and improved LEACH protocols, residual energy levels are considered for CH selection.

These clustering schemes have several advantages such as reduced size of routing table, minimization of bandwidth consumption by avoiding the redundant message exchange, increasing the network lifetime, reduced network overhead. However, despite of several advantages, these schemes suffer from various challenges in the huge network scenario such as optimal number of clusters and CH selection, clustering overhead for mobile node, packet drop and network congestion etc. Hence, the existing clustering schemes need to be improved for better performance of network.

On the other hand, Data Aggregation (DA) is also considered as an important phase of WSNs. According to the aggregation process, sensor nodes collect and combine the desired information from the monitoring area. Below given subsection describes the data aggregation and existing techniques of DA in WSN.

1.2. Data aggregation

In WSN, sensor nodes collect the entire information from the monitoring area. This information also includes thee redundant data which is of no use at the base station. Hence, data aggregation scheme takes place to reduce the data redundancy. Moreover, it reduces number of transmission and helps to save the energy and increases the network reliability and QoS. Severalschemes have been developed for efficient data aggregation such as CSDA [6] uses clustering-based mechanism for DA, energy-efficient and privacy preserving scheme [7] and many more as surveyed in [8]. Generally, the data aggregation techniques are classified in three classes as data level, feature level and decision level aggregation. Moreover, the aggregation methods can be classified as network query, data compression and representative type aggregation based on their aggregation strategy [9]. Current studies reported that data aggregation methods need to be improved further to achieve the efficient outcome of WSN. Existing techniques use simple aggregation methods such as MIN/MAX/SUM which helps to extract the information from sensory data. However, these functions extract limited information due to loss of information. Similarly, the compression techniques fail to achieve the desired information due to lack of prior knowledge of data correlation structure. Currently, clustering is also considered as a promising technique for energy aware data aggregation. Several schemes have been introduced which are focused on clustering-based DA such as CSDA [10]. However, efficient cluster formation and CH selection are the crucial phase of these techniques.

1.3. Work contribution

In this article, we focus on developing an energy aware hierarchal routing and data aggregation. The main aim of this work is two-fold where first of all, we develop a data aggregation method to improve the reliability of the data transmitting with less redundant information in a network and improving the network performance in terms of reduced energy consumption and better QoS. Similarly, we develop a new approach for cluster head selection while performing hierarchical routing.

Organization

The rest of the article is arranged in following sections as: section II presents a literature review study about recent works of hierarchal routing and energy aware data aggregation, section III presents the proposed solution of routing and DA, section IV presents the comparative analysis where we compare the outcome of proposed model with existing techniques and finally, section V presents the concluding remarks and future scope in this research direction.

Literature Survey

This section presents the brief literature review about existing techniques of hierarchal routing and data aggregation.

Hierarchal routing

Zhao et al. [3] introduced 3D WSN model and presented an energy aware method to identify the ideal number of clusters. The existing clustering method causesuneven distribution of energy which creates energy balancing problem. In order to overcome this issue, authors developed dynamic hierarchical clustering technique. This scheme works on three main concepts: first of all, a distance similarity matrix is introduced, followed by, cluster head methodology to reduce the load on the larger cluster and node dormancy model to balance the energy in the dynamic clustering model. Moreover, optimal CH selection is performed based on the residual energy and node positions.
El Alami et al. [11] reported that clustering based mechanisms improve the network lifetime but existing suffer from the redundant data collection. To overcome this issue, authors develop enhanced clustering hierarchy (ECH) scheme. This scheme uses sleep-waking process for overlapping node.

Nori et al. [12] focused on the energy harvesting WSN to increase the network lifetime. In order to mitigate this issue, EDMARA2 (Euclidean Distance Matrix Reconstruction Aided Approach) is developed which is based on the EDM Reconstruction, k-medoids, and ILP.

Zafar et al. [13] focused on mobile WSN and reported that conventional techniques suffer from several performance related issues hence these schemes are not suitable for mobile wireless sensor networks. To mitigate these issues, authors suggested to deal with the mobility issue of sensor nodes and developed two mobility-aware hierarchical clustering algorithms which are: mobility-aware centralized clustering algorithm (MCCA) and mobility-aware hybrid clustering algorithm (MHCA). The MHCA employs centralized gridding for upper layer and MCCA employs gridding at both layers.

Ke et al. [14] introduced a novel energy aware hierarchical cluster-based (NEAHC) routing for WSN. The main aim of this approach are: reducing the total energy consumption and maintaining the fairness between sensor nodes. This model selects the relay node using nonlinear programming problem and convex function to obtain the optimal solution. Hidoussi et al. [15] developed a new hierarchal routing approach for WSN which is called PEAL (Power Efficient and Adaptive Latency).

In [16] Jadidoleslamy et al. reported various challenging issues of WSN such as throughput, scalability, and security. Multipath routing is considered as a promising solution to overcome these issues. However, existing schemes suffer from various issues such as resource consumption, accuracy, and permanent use of available optimal paths. To overcome these issues, authors introduced Hierarchical Multipath Routing Protocol to improve the network performance. This technique divides the operations in multiple rounds known as super round. In each super round, cluster head selection is performed.

1.4. Data aggregation

Data aggregation is also known as the promising solution for energy efficiency and QoS of the network. Various techniques are presented for data aggregation.

Zhang et al. [17] developed Multi-functional secure Data Aggregation scheme (MODA). This approach is termed as multi-functional aggregation because it encodes and preserves value, order and context to construct a well-defined vector. Moreover, this model incorporates a homomorphic encryption-based model to enhance the security during data aggregation. Further, MODA is extended as Random selected encryption-based Data Aggregation (RODA) and Compression based Data Aggregation (CODA). RODA helps to improve the security and CODA helps to reduce the communication cost.

Kang et al [18] focused on minimizing the delay in the network and maximizing the network lifetime by using efficient data aggregation process. Previous studies have reported that duty-cycling or periodically switch ON-OFF processes can help to reduce the energy wastage but it has significant impact on the data aggregation accuracy. In order to overcome this issue, authors introduced distributed delay efficient data aggregation scheduling (DEDAS-D) based on the duty-cycling concept. This scheme constructs aggregation tree and presents a scheduling model to maintain the switch ON-OFF process.

Fang et al. [10] presented energy-efficient secure data aggregation using clustering mechanism. Mainly, this technique is developed by modifying existing CPDA (Cluster-based Private Data Aggregation) where some intrusion detection aspects are incorporated to secure the network from sinkhole and selective forwarding attacks. Moreover, this technique uses data slicing algorithm using tree-structure to reduce the energy consumption and communication overhead.

Hua et al. [19] designed a secure data aggregation method to stop the compromising of sensor node. Hence, an energy-efficient Adaptive Slice-based Secure Data Aggregation (ASSDA) scheme is introduced. This slicing based SDA includes three main phases such as construction of aggregation tree, data slicing, mining and data aggregation.

Hu et al. [7] presented an energy-efficient and privacy-preserving data aggregation algorithm CBDA (the chain-based data aggregation) scheme. According to this approach, the sensor nodes are arranged in a tree topology where leaf nodes connect with other nodes to for the topology. After data aggregation, the privacy policy is incorporated into two phases: first of all, the tail nodes slice the data into J fragments and secondly, J-1 fake fragments are used to interfere with adversaries.

2. Proposed model

In this section, we describe the proposed solution for energy efficient data aggregation and hierarchal routing. The main aim of this work is to increase the QoS of network by improving the data aggregation and network lifetime. First of all, we present the energy consumption and data aggregation model for the considered static wireless sensor network.

2.1. Network model

Let us consider a wireless sensor network where Nnumbers of sensor nodes are deployed uniformly/evenly in a 2D geographical region of radius$R$. During deployment and communication phases, the sensor node can be assigned to any gateway if the communicating sensor node is in the communication range of sensor node. Each sensor node carries the list of other gateways and the sensor can be assigned to one gateway only. For data gathering, we follow the process of LEACH protocol which is performed in multiple rounds. In each round of communication, sensor nodes collect the data from their nearby event and transmit it to the corresponding cluster head. After receiving the data, the gateway nodes perform data aggregation and remove the redundant data and send the aggregated data to the next hop. These communications are performed using a wireless link which is established if the two communicating nodes are in the range of communication.

2.2. Energy consumption model

In order to model the energy consumption model, we consider the distance between transmitter and receiver. Based on this assumption, we consider, free-space and multipath fading channel models. According to the network density, we consider a distance threshold asd_0, if the distance between transmitter and receiver is less than the given threshold distance then we consider free-space model (f_s) otherwise we use multipath model. Let us consider that electronic circuit and amplifier use the energy E_{elec} in free space ϵ_{fs} and multipath (mp) models respectively. Based on this assumption, the required energy by radio to transmit the l bit message over a distance d is given as:

$$E_t(l,d) = \begin{cases} lE_{elec} + l\epsilon_{fs}d^2, & for d < d_0 \\ lE_{elec} + l\epsilon_{mp}d^4, & for d \geq d_0 \end{cases} \quad (1)$$

Similarly, the radio would consume energy while receiving l −bit message, given as:

$$E_R(l) = lE_{elec} \quad (2)$$

The energy consumption parameter E_{elec}depends on various factors such as modulation scheme, encoding model, filtering and signal spreading, similarly, the amplifier energy is given as $\frac{\epsilon_{fs}d^2}{\epsilon_{mp}d^4}$which varies according to the distance between transmitter and receiver sensor nodes.

2.3. Data aggregation

The data aggregation process plays a vital role in WSN for collecting the sensed data from various nodes deployed in the network area. This process helps to aggregate the sensor data thus the data redundancy is minimized and number of transmissions are reduced. Hence, it minimizes energy consumption and delivers the error free data. In this work, the network model performs the task in various round. In one round, sensor node generates the packet, applies aggregation mechanism and forwards the packet to the assigned destination node. This process consumes energy, hence network lifetime also depends on the reliability of data aggregation. Similarly, successful packet delivery helps to determine the QoS level of network. We denote the successful packet delivery rate as ϵ.

Let us consider that γ packet copies are transmitted for one source node n_i, then the packet delivery success rate can be represented as: $\epsilon_i = 1 - \left(1 - S_{ij}\right)^{\gamma}$ where S_{ij} denotes the successful packet delivery from node i to node j. Thus, the overall network reliability can be represented as $\prod_N \left(1 - \left(1 - S_{ij}\right)^{\gamma}\right)$. Transmission of more number of packets improves the rate of packet delivery, however, it consumes extra energy and affects the network lifetime. Hence, data aggregation mechanism is needed. However, the nodes which are near to the sink node face the heavy load because these nodes are treated as relay nodes to aggregate the packet. This event causes energy consumption imbalance. Similarly, the nodes which are far from the sink node, have less load and have more residual energy. These nodes can transmit the extra packets to ensure the efficient packet delivery.

Thus our main aim is to improve the network lifetime while ensuring the efficient packet delivery. The network lifetime is determined by the node which consumes largest energy in each round. Therefore, the objective of this task can be represented as:

$$\begin{cases} Max(T) = Min\left[\max_{0<i<N}(E_i)\right] \\ E_i = P_i^t E_t + P_i^r E_r \\ \dfrac{\sum_k \sum_i \sigma(v_n^i)}{P} \geq \epsilon \end{cases} \quad (3)$$

where P_i^t and P_i^r denotes the packet size of transmitting and receiving node, respectively, $E_t$is the energy required to transmit the data packet and E_r denote the energy required to receive the packet, E_i represents the total energy consumption for node i, $\sigma(v_n^i)$ denotes that whether the generated data packets are successfully transmitted to the sink node. For successful delivery $\sigma(v_n^i) = 1$ and $\sigma(v_n^i) = 0$ if packets are not delivered.

Generally, average function based data aggregation techniques are widely adopted in efficient data collection model. In this work also we use "average" aggregation function. Let us consider that τ denotes the time schedule value for each sensor node present in the current cluster as $\{\tau_1, \tau_2, \dots \tau_k\}$ and τ_i denotes the time schedule for node i. Let K be the total number of sensor nodes in the current cluster head and sensor node aggregates the data in the given time period T as$X = \{X_1, X_2, X_3, \dots X_n\}$. Thus, the aggregation function can be given as:

$$P_{avg} = Avg\left(\sum_{j=1}^{n} X_j\right) \quad (4)$$

This aggregated data is stored in the buffer memory of cluster head and later transmitted to the sink node.

2.4. Hierarchal routing model using clustering

Clustering is considered as an important stage of hierarchal routing where cluster head selection task require evaluation of several parameters of sensor nodes. However, due to varying energy and node parameters, the selected cluster head is not always considered as the stable solution for current deployment of WSN. Hence, dynamic cluster head selection takes place. LEACH is a widely adopted clustering mechanism in WSNs. According to mechanism of LEACH, we assume that initial energy of each node is same. This approach distributes the network operating time into multiple time slots which are known as rounds. Based on mechanism of LEACH protocol, it elects $p_{opt}N$ number of cluster heads in each round where p_{opt} denotes the optimization probability of cluster head. Similarly, DEEC also elects the cluster head but the probability of sensor node to be elected as cluster head is different. The DEEC protocol uses a threshold $T(s_i)$ which is given as:

$$T(s_i) = \begin{cases} \dfrac{p_{opt}}{1 - p_{opt}\left(rmod\dfrac{1}{p_{opt}}\right)}, if\, s_i \epsilon G \\ 0, otherwise \end{cases} \quad (5)$$

Where G denotes the eligible nodes for cluster head election process in round r, p_{opt} denotes the average probability of cluster head. These algorithms are widely used in various WSN systems however, there are three main drawbacks: (i) these routing schemes don't focus on the location of CH node i.e. if the CH node is located at a far position from base station. In this case, the sensor node dies without performing any tasks. This leads towards the energy hole formation. (ii) These routing schemes do not consider energy consumed in data aggregation, hence the overall network lifetime cannot be prolonged and (iii) there are no special arrangements in routing to ensure the successful packer delivery to the base station. In order to mitigate with these issues, we present an adaptive routing mechanism and introduced a novel threshold function for cluster head selection. The proposed threshold function considers node location and residual energy as the important factor. The threshold function can be given as:

$$T(s_i) = \begin{cases} \dfrac{W_b p_i}{1 - p_i\left(rmod\dfrac{1}{p_i}\right)}, if\, s_i \epsilon G \\ 0, otherwise \end{cases} \quad (6)$$

Where$W_b = A\frac{E_i(r)}{\bar{E}(r)} + B\left(1 - \exp\left(-\frac{d_{avg}}{d(i)}\right)\right)$. Here, A and B are the two constant which are ranging from 0 to 1, the sum of A and $B$is 1, d_{avg}denotes the distance between CH and BS, $E_i(r)$ denotes the remaining energy of node in r^{th} round and $\bar{E}(r)$ is the average energy in r^{th} round. For even distribution of sensor nodes, the average distance between cluster head and base station can be computed as:

$$d_{avg} = \int_A \sqrt{x^2 + y^2}\,\frac{1}{A}\,dA \quad (7)$$

For heterogeneous networks, the initial energy is randomly distributed as $[E_0, E_0(1 + \alpha_{max})]$ where E_0 be the lower bound of distribution andα_{max} is used to determine the maximum energy value. The total energy of heterogeneous network is given as:

$$E_{total} = \sum_{i=1}^{N} E_0(1 + \alpha_i) \quad (8)$$

It is obvious that the cluster member nodes which are not cluster head, transmit the L bit size data packet in each round.

Hence, The total dissipated energy for each round can be given as:

$$E_{round} = L\left(2NE_{elec} + kE_{mp}d_{toBS}^4 + NE_{DA} + NE_{fs}d_{toCH}^2\right) \quad (9)$$

In case, we make an assumption that all node die at same time then the number of round where node starts dying at R number of round, then the$R$ can be expressed as:

$$R = \frac{E_{total}}{E_{round}} \tag{10}$$

Based on the same assumption, the average energy $\bar{E}(r)$ for round$r$, can be estimated as:

$$\bar{E}(r) = E_{total}\frac{1}{N}\left(1-\frac{r}{R}\right) \tag{11}$$

With the help of equation (6) and (13) it can be concluded that when threshold value is increased the cluster head selection probability also increases. In this approach, we conclude that the node which is having higher residual energy and located closer to the base station has the higher probability to be selected as cluster head.

In this work, we use a distance threshold parameter to distinguish the location of CH whether it is located nearby or far from the base station. This threshold can be expressed as:

$$d_h = \beta d_0 \tag{12}$$

Based on the Eq. (1), we can conclude that if the d_h is larger than d_0 then we adopt multi-path model to compute the energy consumption. Moreover, we introduce a decision function between cluster head and base station to perform the certain operations. This decision function can be expressed as:

$$W_n(i) = \frac{E_{res}(j)}{E_{res}(i)} + \frac{2 \times d(ch_i, bs)}{d(ch_i, ch_j) + d(ch_j, bs)} \tag{13}$$

Where $d(ch_i, bs)$denotes distance between cluster head and base station, $d(ch_i, ch_j)$ is the distance between ch_i and ch_j. During the first phase of communication, the CHs broadcast their own packet which contains information as node id, residual energy and node distance from base station. This packet format is given in below given table 1.

Table.1. Initial Packet structure

Node ID	Residual Energy of i^{th} node	Distance from base station (current node)
ID_i	$E_{res}(i)$	$d(ch_i, bs)$

The communication model of proposed approach is as follows:

- First of all, we measure the distance between cluster head and base station as $d(ch_i, bs)$. If this distance is greater than the threshold d_h, then we use multi-hop routing. Here, we use the proposed decision function and consider the values of two neighboring cluster heads. The cluster head with largest value is selected as next-hop to transmit the packet further.

- On the other hand, if value of $d(ch_i, bs)$ is less than the threshold, then cluster head is eligible to communicate directly to the base station.

3. Results and discussion

This section describes the outcome of proposed energy-aware hierarchal routing and data aggregation schemes for the considered WSN. In order to show the novelty of this approach, we compare the outcome of this approach with existing routing schemes in terms of number of alive nodes, energy consumption, and packet delivery ratio. For this complete simulation, we have considered several parameters as mentioned in below given table 1

Parameter Name	Value
Base station position	Centered (50x50m)
Number of nodes	100-400 nodes
Initial energy	100J
Radio elec energy	50nJ/bit
Radio propagation	Free space
ϵ_{fs}	10 pJ/bit/m
ϵ_{mp}	0.0015 pJ/bit/m^4
Packet size	512 Bytes

Initially, we have deployed 400 nodes with an initial energy of 100 J. It is assumed that each node transmits a packet of size 512 byte in a free space model. The obtained performance is compared with SEP [20], H-HEED [21], EECPEP [22], MDEC [23], and NR-MDEC [23].

Below given figure 1 illustrates the comparative analysis in terms of network lifetime where we have measured the node dead rate by identifying the rounds of dead node counts. The obtained performance is compared with SEP [20], H-HEED [21], EECPEP [22] for varied number of nodes.

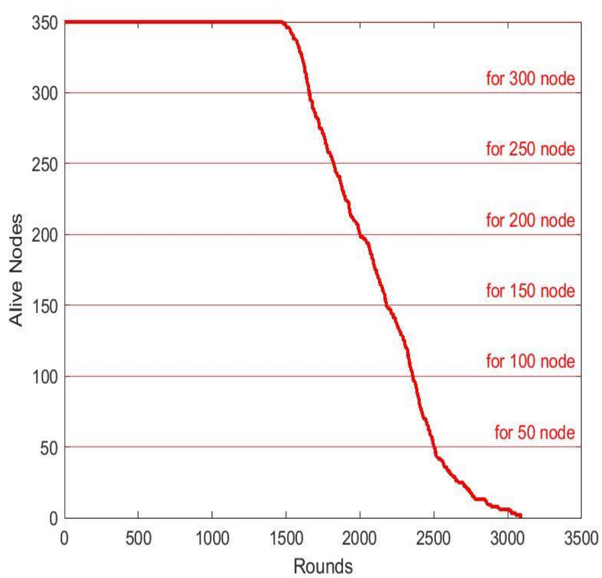

Fig.1 network lifetime performance

In this experiment, we have varied the number of node from 50 to 350. These algorithms are based on the rounds, hence, as the number of rounds and nodes are increasing, the network lifetime also decreases however, proposed ADA-HR approach achieves promising performance for each scenario when compared with state-of-art techniques. In this experiment, we obtained the average network lifetime as 747.85s, 814.28s, 995.71sand 1278.57s using SEP, H-HEED, EECPEP and Proposed ADA-HR, respectively.

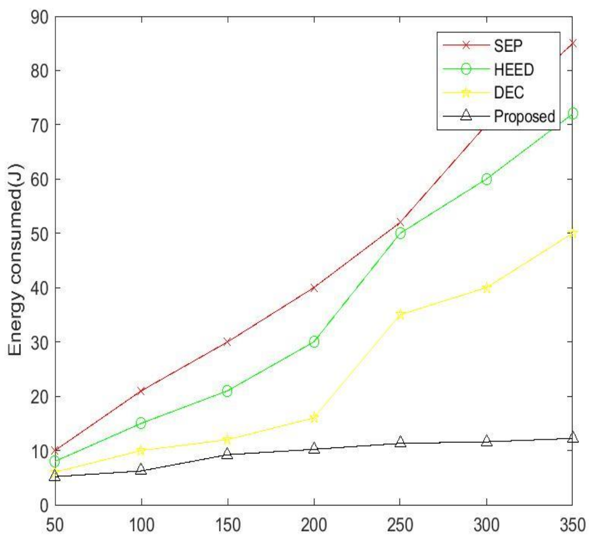

Fig.2. Energy consumption performance

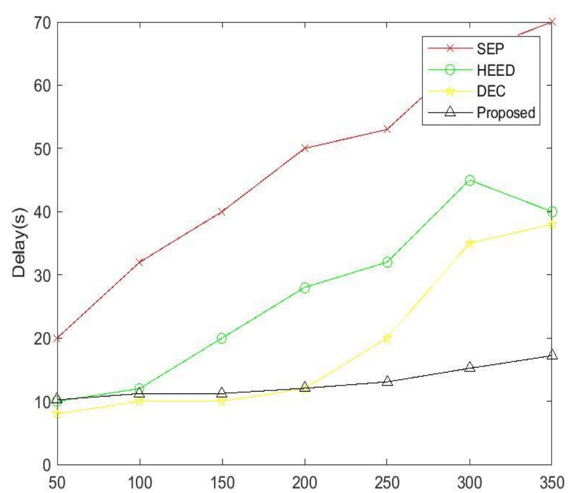

Fig.3. End-to-End delay performance comparison

In figure 2, we measured the performance in terms of total energy consumption for complete simulation. It is obvious that more number of nodes will consume more energy but proposed approach uses energy balancing scheme and helps to minimize the energy consumption. In this experiment, we observed that average energy consumption of SEP, H-HEED, DEC and Proposed ADA-HR is 44 J, 36.57J, 24.14J and 12.85J, respectively.

Similarly, In Figure3 we measure the performance in terms of end-to end delay for varied number of nodes. The obtained performance is depicted in below given figure 3. The existing schemes suffer from the network congestion issue due to which the data need to store in buffers whereas proposed approach minimizes congestion because of its weight function which selection next hop optimally. Moreover, the data aggregation process minimizes the network overhead. Above given figure 3 shows the comparative performance in terms of end-to-end delay. The average end-to-end delay is obtained as 47.14s, 26.71s, 19s and 12.71s using SEP, HEED, DEC, and Proposed ADA-HR, respectively.

Further, we compare the performance in terms of packet delivery for varied packet size. The proposed scheme improves the network lifetime along with the efficient packet delivery. This helps to increase the network throughput. Below given figure 4 shows the comparative performance in terms of network packet delivery.

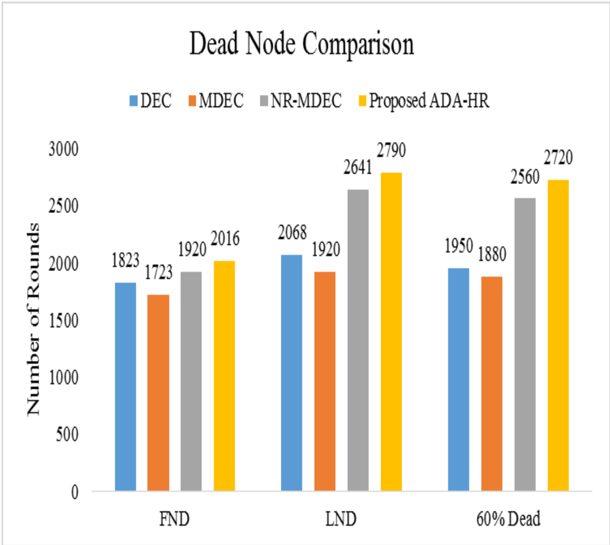

Fig.5. dead node comparison

According to this experiment, we prove that proposed approach prolongs the network lifetime because in this approach, the first dead node is identified on round 2016 and last dead node is obtained at round 2790 which is higher than the existing approaches.

4. Conclusion

In this article, we focused on performance improvement of wireless sensor network in terms of energy efficiency and Quality of Service. The hierarchal routing is considered as a promising solution to achieve the desired performance in WSN. Several routing schemes have been introduced in the past based on hierarchal routing but those techniques suffer from various challenging issues such as distance between nodes and relay nodes. Due to increased distance, sensor nodes drop the packets which affect the network performance and overall QoS. In order to deal with these issues, we presented a combined approach of data aggregation and hierarchal routing. The data aggregation approach is performed based on the average function, and hierarchal routing uses a newly designed cluster head selection and weight function. The performance of proposed routing scheme is compared with various state-of-art techniques. The comparative analysis validates that the proposed approach attains better QoS and network performance.

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