AMOCH-EPSOR – A multi-objective CH selection and Enhanced Particle Swarm Optimization for relay selection with Mobile sinks

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Abstract

By relying on the application, a wireless sensor network could be heterogeneous in nature, which means the sensor nodes either static or mobile based on the requirements of an application. The energy-hole problem may cause by the static deployment of source nodes and sink due to the nodes should always be active in the sink's one-hop neighbour for data transmission from the source nodes. The coverage holes is resulted and network performance is reduced. For efficient data aggregation and QoS maintenance, one of the optimal methods is used as the clustering. More energy is consumed by the Cluster Heads (CH) that located near BS in cluster-based WSNs and their energy exhausts with rapid speeds than the other ones. Thus, the premature death of nodes and frequent rotation of CH have resulted. The Enhanced Particle Swarm Optimization and a multi-objective CH selection have introduced for relay selection with mobile sinks (MOCH-EPSOR) for improving the sensor network lifetime and CH stability for energy-efficient data aggregation. A single mobile sink deployment in larger networks is lead to different problems in large networks such as end-to-end delay in data collection, coverage, and node failure or link failure, etc. In this paper, multiple mobile sinks have introduced. Different multi-objective parameters like link quality, residual energy, communication cost, and node proximity are also considered for improving the stability of CH that enhances the data aggregation. For detecting the optimized route between member nodes and cluster head, an enhanced Particle Swarm Optimization (PSO) algorithm is incorporated with a modified fitness function for energy-efficient data transmission. For aggregation from the respective CHs, the MS's are moving along the clusters and retain in each cluster for certain time period after data aggregation at CHs. The experimental results proves that the proposed MOCH-EPSOR scheme improves the network lifetime and QoS than the previously proposed energy efficient protocols.

I. Introduction

A wide range of small and inexpensive sensor nodes are contained in WSNs and they generate the data for transmitting to BS through single or multi-hop data transmission [1]. The applications of WSNs include environmental monitoring, battlefield monitoring, and target tracking. It is not possible to replace the sensor nodes' battery power. So, the network lifetime is dependent on the sensor node's power consumption, which is the main constraint of WSN. The computation, sensing, and wireless communication are the major functionalities WSN, Cluster heads, Energy efficiency, Optimization, Data aggregation, LEACH.of sensor node [2]. More power is utilized by the communication of sensor nodes rather than computation and sensing.

For decreasing the transmission amount, various routing protocols have introduced for WSNs that leads to the subsequent reduction of power. The data transmit from the sensor node to BS in WSN [3] and BS is usually located at the centre of a network. The data packet needs to travel for a long distance when a sensor node locates far away from the BS and it results in consumption of more power. The sensor node locating around the BS is called as the bottle-neck zone, which depleted the battery energy of a node faster and experience heavy traffic flow [4]. The earlier death of nodes is caused in bottle-neck zone that affecting the connectivity and lifetime of a network.

Energy efficiency could improve using the clustering, which is one of the most efficient and promising solutions. More energy is consumed by CHs that locating around BS in multi-hop cluster-based WSNs. The CHs relay the information between other CH nodes apart from data packets transmission and collection from the member nodes [5]. The CHs nearer to the SINK consume the power more quickly compared to the outer ones that leads to energy holes and premature death of nodes in a network. The existing methods transmit the cluster’s member nodes to their respective CHs directly in intra-cluster communication. For data packets transmission, more energy requires for the nodes that located far away from CH as the member nodes’ energy consumption relied on their transmission power [6]. The member nodes’ energy consumption is increased with the increasing of distance between CH and member nodes. The node depletes its power supply earlier than other remaining nodes when it is located distant away from CH.

The most essential component of a network is the SINK in WSNs that is the only gateway between users and network. In general, the sink, which larger computational power and unlimited energy supplies is considered. The network performance and energy efficiency have increased by the mobile sinks. The data packet’s number of hops that traverses to reach out the SINK could minimize by the sink mobility and it reduces the consumption of power in data collection. A single mobile sink of a network causing different issues such as link failure or node failure, coverage, and end-to-end delay in data collection, etc. specifically in larger WSNs. CH stability is required for increasing the network lifetime. For energy-efficient data aggregation, a multi-objective CH selection and Enhanced Particle Swarm Optimization for relay selection with Mobile sinks (MOCH-EPSOR) is introduced. The proposed data aggregation scheme achieves significant network lifetime improvement and QoS of the network.

Contributions in this paper

- In the proposed MOCH-EPSOR scheme, multiple mobile sinks are introduced to cover the entire network. A network with a single mobile sink results in link failure, bad coverage, and end-to-end delay, etc. The usage of multiple mobile sinks avoids these issues in an efficient way.
- The mobile sinks will move in the GRID mobility pattern and stay at the CHs for limited period of time to cover the maximum network area in a smaller time.
- The network is clustered for efficient data aggregation and the CHs are selected based on multi-objective parameters like node proximity, communication cost, link quality and residual energy in order to increase the CH stability.

- This multi-objective based CH selection method reduces the frequent CH rotation and increase the CH lifetime.
- The modified fitness function used in the enhanced PSO algorithm improves the energy efficient by selecting the optimal relay nodes between the cluster head and member nodes. It helps the network to prolong its lifetime.

II. Literature survey

The recent works are mostly focused on mobile sink based WSN. By using attribute-based naming, the data centric routing uses in directed diffusion [7] and the interest for data-queries broadcast by the mobile sink. Entire network categorizes into small grids in Two-Tier Data Dissemination (TTDD) [8] based on grid-based approach. The location data for routing includes in the sensor node that nearer to the grid point that can be acted as dissemination node. Through reverse path, the node reply is done by sending the data queries using mobile sink to the nearest grid that routed to other grid points. Less control overhead is contained in the TTDD based technique than the other protocol. Based on the feature of broadcasting of wireless medium, an efficient Data Drive Routing Protocol (DDRP) has provided the route learning in [9], where recording option is included in the data packet for each listener to learn the route to mobile sink.

Chu-Fu Wang et al., [10] proposes an energy-aware sink relocation (EASR) technique by implementing MCP as an energy-efficient routing as underlying method for message relaying. The network lifetime can prolong by using EASR based on the theoretical analysis. The experimental simulation results show that the proposed technique is outperformed than the other existing methods.

A.Muthu Kumar and P. Ganesh Kumar et al., [11] have utilized the data collection based on the clustering architecture with TDMA slots for energy-efficient data gathering approach. By analysing the network lifetime, received data packets, and residual energy, the proposed model's efficiency is evaluated and achieved increased network lifetime while reducing power consumption.

Omer Cayirpunar et al., [12] has proposed BS mobility to overcome the hot-spot problem of sensor nodes and mitigate the sub-optimal energy dissipation. When compared to the single BS, the multiple BSs extends the lifetime of WSN. For achieving the maximum WSN lifetime, optimal mobility patterns of multiple mobile BSs. Based on three representative parameters like spiral, random, and grid, the optimal mobility patterns' features are investigated. A novel mixed integer programming framework is developed for characterization of network lifetime.

Amer O. Abu Salem and Noor Shudifat et al., [13] have investigated the power sensitivity if cluster heads that have minimum distance to the BS by sensor nodes. The proposed approach power sensitivity characteristics were studied by comparing with LEACH protocol. The simulation results reveal that the energy consumption is reduced that increases the network lifetime.

III. Proposed system

Assumptions

For building a network model, the below-mentioned network characteristics are considered such as:

- The random deployment of nodes over the sensing field and all nodes are assumed as static.
- Within the sensing field, all sensor nodes are heterogeneous and different bandwidth and energy levels are contained for nodes initially.

- The transmission power is used by sensor nodes using the distance to reach the destination nodes.
- Any resource constraints are not included in mobile sinks, which are highly powered.
- For the routes readjustment, the Time of Arrival (TOA) and latest location of sink will communicate to the limited number of cluster head nodes.

Radio energy model

For running the power amplifier and radio electronic, the energy consumes by the transmitter in the radio model that uses in the experiment. The energy is consumed by the receiver only for running the radio electronic. Below equations (1) and (2) represent the energy consumption for transmitting and receiving k bit data as follows:

$$E_{trans} = k(E_{ec} + E_{dis} * D) \tag{1}$$

$$E_{recv} = k(E_{ec}) \tag{2}$$

E_{ec} indicates the electronic energy that relied on the filtering, digital coding, and signal spreading, E_{dis} refers to the dissipated energy in the data transmission, and D represents the distance between source and destination.

The below equation (3) shows the total energy that spent at the CH level for aggregating the bit data k:

$$ECH_{agg} = E_{agg} * k * n \tag{3}$$

Where, E_{agg} refers to the energy amount required for one bit data transmission, ‘n’ relates to the transmitted number of messages, and ‘k’ indicates the number of bits in a packet.

Proposed scheme

A multi-objective CH selection and Enhanced Particle Swarm optimization for relay selection with mobile sinks (MOCH-EPSOR) is introduced for energy-efficient data aggregation and improving the network lifetime. The deploying a single mobile sink in large networks has resulted in different issues like end-to-end delay, coverage, and node failure or link failure. It’s required to introduce multiple mobile sinks for a network. The CH stability is improved by introducing multi-objective parameters like link quality, residual energy, communication cost, and node proximity that enhances the data aggregation. For detecting the optimized route between the member nodes and the cluster head, an improved Particle Swarm Optimization (PSO) algorithm is incorporated with a modified fitness function after CH selection for energy-efficient data transmission. In this efficient path, the data aggregation is performed at CHs. MS’s are moving along the clusters and stay in each cluster for limited time period to aggregate the data from the respective CHs it visits.

Cluster formation and multi-objective CH selection

Based on the approach of unequal node clustering, the nodes clustering is carried out in a network. Different benefits of load balancing, scalability, a higher lifetime, etc. have provided by the unequal clustering technique. At the area closer to BS, the intra-cluster communication is reduced and the overload prevents for the nodes next to the sink node.

The adjacent SNs need to detect by the sensor nodes for creating the clusters. To detect the adjacent nodes, node ID, its location, and ID are required. For determining the distance, Euclidean distance formula is used using below equation (4):

$$DIST_{i,j} = \sqrt{(X_i - X_j)^2 + (Y_i - Y_j)^2} \tag{4}$$

In the above equation (4), X, Y are the location coordinated of the nodes $i \ and \ j$ in the network area.

The distance between the sensor nodes and the base station node is calculated using the above mentioned Euclidean distance as followsequation (5):

$$Dist_{NtoBS} = POS_N - POS_{BS} \tag{5}$$

Using the above equations, the adjacent node of the sensor nodes can be estimated using the following expression (6):

$$N_{adj} = sin\left(\frac{DIST_{i,j}}{2}\right) + cos(POS_i) * cos(POS_j) * \left(sin\left(\frac{Dist_{NtoBS}}{2}\right)\right)^2 \tag{6}$$

Finally, the number of clusters that can be formed within the network area can be represented as followsequation (7):

$$N_{CL} = \frac{N}{\sqrt{2\pi}} * \frac{M}{Dist_{NtoBS}} \tag{7}$$

CH selection

A probabilistic approach is implemented for CH selection that chooses the best node as a CH in the cluster using multiple objectives, including residual energy, link quality, node proximity, and communication cost. The energy is used by the nodes in a network for processes like transmission, data collection, and reception. The energy will use by CH nodes than the other remaining nodes in the clustered networks because of the collected data aggregation, transmission and reception of data from different sensor nodes. For performing such type of tasks, more energy is needed for these nodes. An efficient CH selection method is required in this case. For enhancing the efficiency of data aggregation, the multi-objective parameters is used to select the stable CHs.

Objective 1: Node proximity

The nodes' selection with improved connectivity is allowed in the proximity approach. A continuous connectivity is provided with improved lifetime. Based on the distance between nodes, the node proximity is estimated using below equation (8):

$$PR = \frac{1}{M} * \sum_{i=1}^{1-M} DIST(i,j) \tag{8}$$

Here, M is total number of nodes in the network and the distance between the node and the neighbour is denoted as $DIST$. Therefore the node proximity for the entire node is described as followsequation (9):

$$NP = \frac{1}{M} * \sum_{i=1}^{N} PR\,(N) \tag{9}$$

Objective 2: communication cost

The communication cost of the node describes how expensive the node is for communication or the price required for node to communicate with the neighbour. It can be represented as followsequation (10):

$$Com_{cost} = \frac{DIS_{avg}}{R} \tag{10}$$

R indicates the nodes' radius and DIS_{avg} refers to the average distance among the node and its neighbour. This can be summarised for all the nodes as follows equation (11):

$$TC = \frac{1}{M} * \sum_{i=1}^{N} Com_{cost} \tag{11}$$

Objective 3: link quality

The link quality is estimated by utilizing current coordinate and the link quality between nodes can be as follows equation (12).

$$L_{quality} = \frac{1}{(1- {R_n}/{Tx_n} + 1)} \tag{12}$$

Here, LQ_n denotes the link quality of the node n, R_n denotes the radius of the node n, Tx_n denotes the maximum transmission range of the node. It can be summarized as followsequation (13):

$$LQ = \frac{1}{M} * \sum_{i=1}^{N} L_{quality}(N) \tag{13}$$

Objective 4: residual energy

The residual energy of the node is calculated as followsequation (14):

$$E_{res} = E_{total} - (E_C + E_T + E_R + E_A) \tag{14}$$

Here E_{total} is total energy, E_C is energy utilized during data collection, E_T&E_R are the energy utilized during data sending and receiving respectively and E_A is used energy for data aggregation using below equation (15).

$$RE = \frac{1}{M} * \sum_{i=1}^{N} E_{res}(N) \tag{15}$$

For management of trade-off between the coordinates, the Weighted Sum Approach (WSA) is used to improve a multi-objective fitness function. The weight value is multiplied on each objective for obtaining the objective value. With the addition of multiplied values, transform the different objectives as a single scalar objective function as a final point as follows:

$$fitness = \left(\alpha 1 * \left(\frac{1}{M} * \sum_{i=1}^{N} PR(N)\right)\right) + \left(\alpha 2 \left(\frac{1}{M} * \sum_{i=1}^{N} Com_{cost}\right)\right) + \left(\alpha 3 \left(\frac{1}{M} * \sum_{i=1}^{N} L_{quality}(N)\right)\right) + \left(\alpha 4 \left(\frac{1}{M} * \sum_{i=1}^{N} E_{res}(N)\right)\right) \tag{16}$$

Where, α1 + α2 + α3 + α4 = 1. The main objective is used to maximize the fitness value and is given as, Objective: Maximize Fitness.

The node will select as a CH when it satisfies all objectives, which means the nodes with coverage and higher energy will be chosen at proximity and low cost. For data aggregation, the chosen CH is used in each cluster and the packets forwarded to BS directly through other hops. For data transmission to CH, the route will detect by choosing the CH on each cluster.

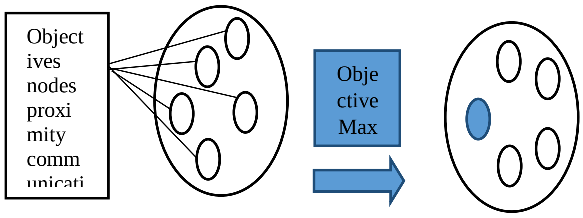

fig1: CH selection using multi-objective fitness function

Data transmission

Particle swarm optimization

The bird flocking and fish schooling have inspired to develop the Particle Swarm Optimization (PSO). These birds moving together regularly in a group without any colliding for food searching or shelter. By adjusting the member's position and velocity, the group data is followed by each member or bird in a group. Due to the sharing of group data, the searching effort of individual or member for shelter and food reduces in a group.

The predefined number of particles (Sn), each particle provides solution to a particular problem instance is contained in PSO. A fitness function evaluates each particle and same dimension will include for all particles. Each particle Pi has velocity (Vel_{id}) and a position ($P_{i,d}$) in the dith dimension of hyperspace. Equation (17) represents the particle Pi at any point of time:

$$P_i = P_{i,1}, P_{i,2}, P_{i,3}, \dots . P_{i,d} \tag{17}$$

For updating each particle's velocity and position iteratively, each particle Pi follows its own global best (Gbest) and own best (Pbest) for reaching the global best position. Until Gbest is reached or the maximum iterations count, the update process is repeated.

Relay node selection using EPSO

The collected data transmit to their respective CHs by sensor nodes based on the relay nodes in the data transfer phase. From sensor nodes to CHs, the data is transmitted via multi-hop relay nodes. The PSO method is used in the proposed method for choosing efficient relay nodes for data transmission to save the energy of a network. In the proposed scheme, the PSO technique is used for designing an improved fitness function to choose the relay nodes between CHs and sensor nodes. The proposed fitness function evaluates the fitness value of particles by considering sensor nodes as particles. From the chosen set of sensor nodes, the most efficient sensor node is chosen as relay using the fitness function that considers the received signal strength RSSI, transmission delay, node distance to CH, and residual energy. A fitness value pbest is generated by the proposed relay selection method for each sensor node to be participated in the process of relay node selection using fitness parameters. The relay competition wins by the node with highest fitness value Gbest and it serves as a relay node to transmit the information to CH.

Relay node selection parameters

For selection of relay node, the PSO technique uses based on the parameters like RSSI, node residual energy, distance to CH, and transmission delay. In selecting the efficient CH node as a relay, the parameters of relay selection are playing a crucial role. In order to save battery power, the data forwards to the CH from member nodes using the relay node. For generating the fitness values for CH nodes that participate in the relay selection, the PSO technique is used the parameters of relay selection as follows:

(a) Residual Energy: The data transmit from all member nodes to their respective CHs based on the relay nodes. In the relay selection, the most essential parameter is used as the energy. The relay duties can perform by the higher energy node efficiently and can survive for a longer period. During data transmission, the node with minimum energy may die or stop functioning owing to the insufficient energy. It can formulate using below equation (18):

$$f_1 = \frac{1}{M} * \sum_{i=1}^{N} E_{res}(N) \tag{18}$$

(b) Distance between CH and member: It is referred to the average distance between sensor node and their respective CHs. Maximum distance means maximum hops are involved which could increase the energy consumption of the sensor nodes. So, the distance to the CH should be considered to select the minimum hop nodes to save considerable amount of energy in sensor nodes. It can be formulated as in equation (19).

$$f_2 = \sum_{j=1}^{m} \left(\sum_{i=1}^{lj} dis(S_i, CH) \right) \tag{19}$$

(c) Transmission delay: It is the transmission time delay exist between the sensor nodes. If the delay increases, then energy consumption also increases in the network. The relay nodes should have minimum time delay for efficient data transmission. By relying on the transmission delay (TD), propagation delay PD, and expected transmission count (ETC) of the node, the delay of node is resulted in a network and it formulates using equations (20) and (21):

$$Delay\ D(t) = \sum_{i=1}^{m} ETC_i(t)(TD + PD_i) \tag{20}$$

$$f_3 = \sum_{i=1}^{m} \min\left(Dt_{Si}\right) \tag{21}$$

(d) Received signal strength (RSSI): It is the connection between received and transmitted power of wireless signals and distance among nodes. It can estimate as follows:

$$RSSI_n = T_p * \left(\frac{1}{d}\right)^n \tag{22}$$

T_p refers to the wireless signal’s transmitted power, n is the transmission factor, and d indicates the distance between sending and receiving nodes. Here, n relies on the propagation environment.

A fitness value generates for all nodes that participating in the relay selection of enhanced PSO technique. A message that contain the node ID and fitness value to the nodes is broadcasted by the nodes after generating the fitness values. In the cluster, the participated nodes in the relay selection compared each other for sensor nodes. The node that has the great fitness value will choose as an optimal relay and is served as a relay node for data transmission to CH. For the relay selection, the fitness function is given as (23) and (24):

$$pbest_i = \omega_1 * f_1 + \omega_2 * f_2 + \omega_3 * f_3 + \omega_4 * f_4 \tag{23}$$

$f_1 = max\{residual_{energy}(n)\}, \quad 1 \le n \le N,$

$where\ N = total\ number\ of\ nodes$

$$f_2 = minimize\ \{distance(S_i, CH)\}$$

$$f_3 = minimize\{delay(S_i)\}$$

$$f_4 = \max\ \{rssi(S_i)\}$$

$$pbest_i = \omega_1 * \frac{1}{M} * \sum_{i=1}^{N} E_{res}(N) + \omega_2 * \sum_{j=1}^{m}(\sum_{i=1}^{Ij} dis(S_i, CH))$$

$$+ \omega_3 * \sum_{i=1}^{m} \min\ (Dt_{Si})$$

$$+ \omega_4 * T_p * \left(\frac{1}{d}\right)^n \tag{24}$$

$$Gbest_i = max[pbest_i]$$

Where $\omega_1, \omega_2, \omega_3, \omega_4,$ is the weight coefficient for the fitness functions ranging between 0 and 1. $(0 < \omega < 1)$

The relay competition wins by the node, which includes the great fitness value and the relay job is gotten. The collected data is forwarded from sensor nodes to the nearest relay node and the data forward by the relays to the nearest relay. This data is finally reached to CHs.

Mobile SINK and data aggregation

The cluster based data gathering technique is used in the proposed method, which adapts heterogeneous WSN in a way that the maximum fitness nodes use as cluster head. From all nodes, the message transmitted to the CH in a cluster via optimal relay nodes that chosen using enhanced PSO algorithm. After it is coming into contact, the message is buffered and transmitted to the mobile sink. Multiple mobile sinks have exploited for data collection from CHs after aggregating the data for saving CHs energy from sending data to the SINK that exist in location far away from sensor nodes. High computing resources like buffer size and energy is equipped for each mobile sink, which initiates the route of data gathering periodically from the site and collects data directly from the cluster heads in a single-hop range. It returns to the starting site again.

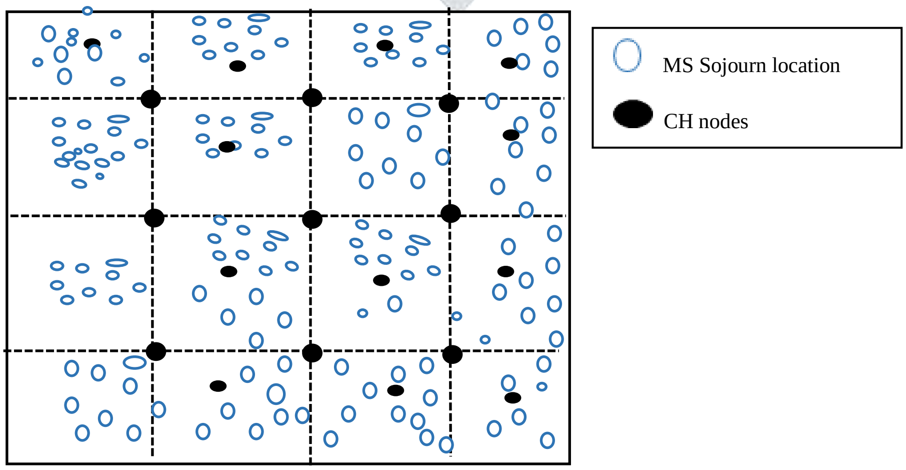

Fig 2: grid mobility pattern of mobile sinks

The mobile sinks move by following grid mobility pattern and advertise its movement and location through advertisement messages. Once the one-hop connectivity with CHs established the mobile sinks decide the sojourn point and stay until it collects the data from CHs. Then it continues the journey and decide the sojourn time and location based on CHs location and connectivity.

Algorithm

NP – node proximity; COM_{cost} – communication cost; LQ – link quality; RE – residual energy;

##

For all the nodes n

    Divide the network as 'k' clusters

    For each cluster 'k'

        CH selection using multi-objective parameters

            For each cluster node

                CalculateNP, COM_{cost}, LQ, RE

            End for

            Calculate $fitness = NP + Com_{cost} + NP + RE$

            If ($fitness\ is\ MAX$)

                Select the node as CH

            End if

    End for

Data transmission phase

        Calculate $pbest$

        If $pbest_j > pbest_i$

            $pbest = pbest_j$

        End if

        If $pbest_j > Gbest$

            $Gbest = pbest_j$

        End if

Compute relay nodes using $Gbest$

End for

IV. Result and Discussion

The proposed method simulates in a 1000*1000 m square region with 100 to 500 nodes for evaluating the efficiency. The radio model's parameter value is given in Table.

The proposed method is compared with the multiple mobile sinks based data aggregation method [11] and Enhanced LEACH algorithm [13].

Table1: Simulation parameters

Parameter	**Value**
Network area	1000x1000
Number of nodes	100 to 500
Initial energy	80j to 100j
Packet size	1024
MS mobility pattern	GRID

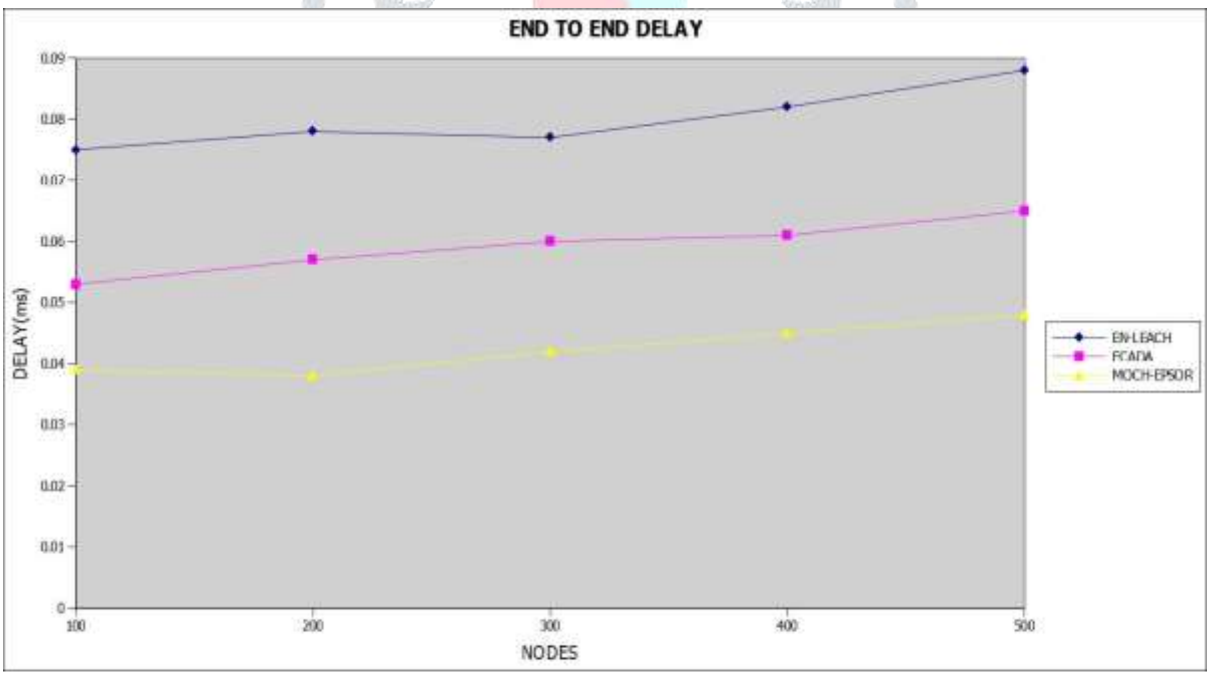

Fig.3: End-to-end delay vs Nodes

The above figure 3 demonstrates the evaluation of end to end delay time for the data transmission.. The consideration of parameters like helped the proposed method to select the minimum hop path and to achieve the minimum time delay compared with the existing methods..

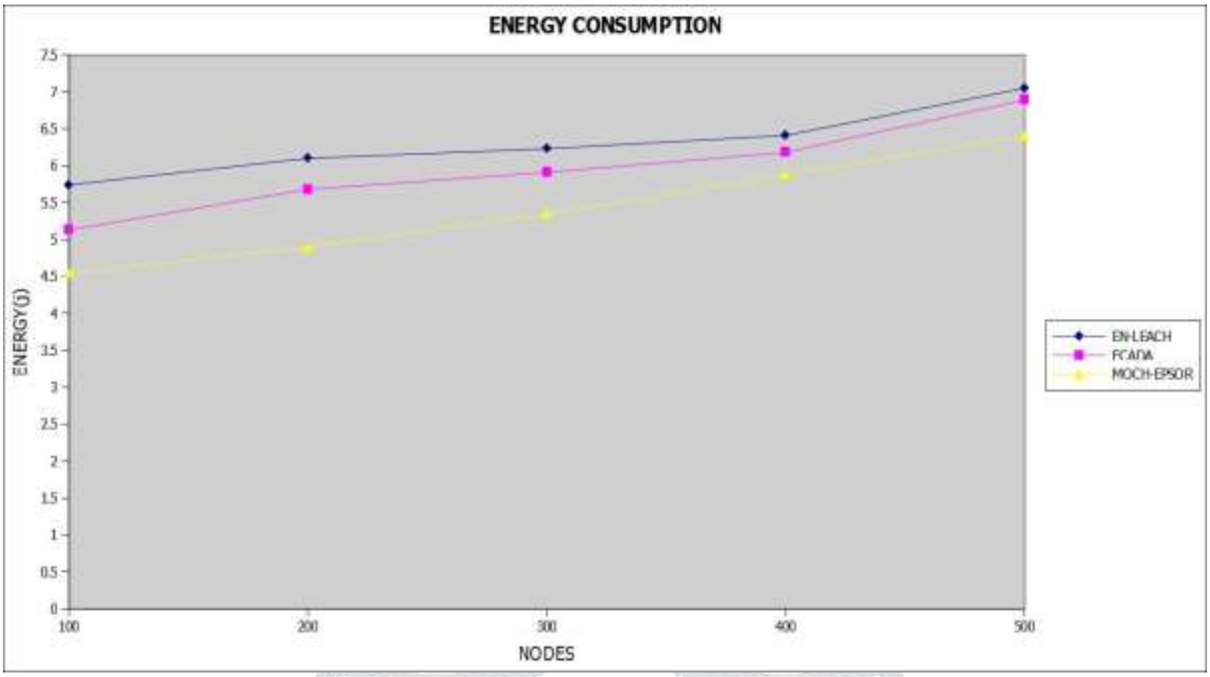

Fig 4: Energy consumption Vs. Nodes

The above simulation results as figure 4 shows the energy consumption rate of the both existing & proposed methods. The reason for the low energy consumption was the consideration of the parameters such as residual energy, transmission delay and signal strength.

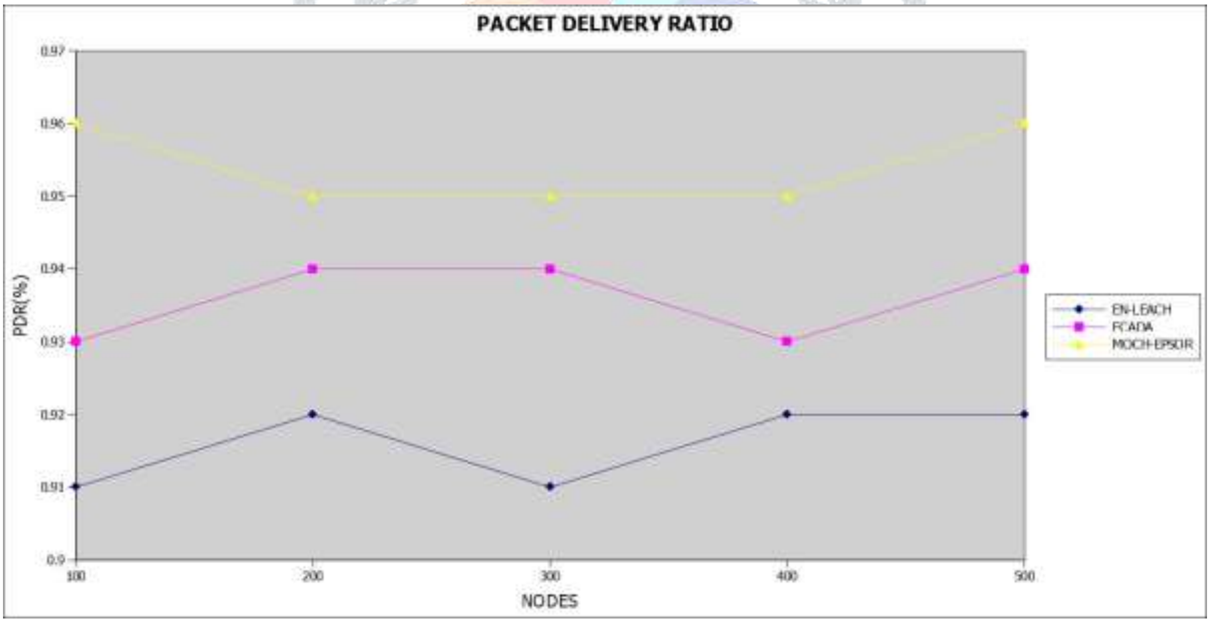

Fig 5: Packet delivery ratio vs Nodes

The above figure 5 demonstrates the simulation results of packet delivery ratio for the proposed & existing methods. PDR defines the quality of the network for data transmission. The proposed method achieved maximum PDR of 0.95% whereas the existing methods maintained the average PDR rate of 0.92& 0.91 respectively. The multi-objective parameters such as transmission delay and distance between the nodes helped the proposed method to select efficient path for communication and helps to outperform than the existing methods.

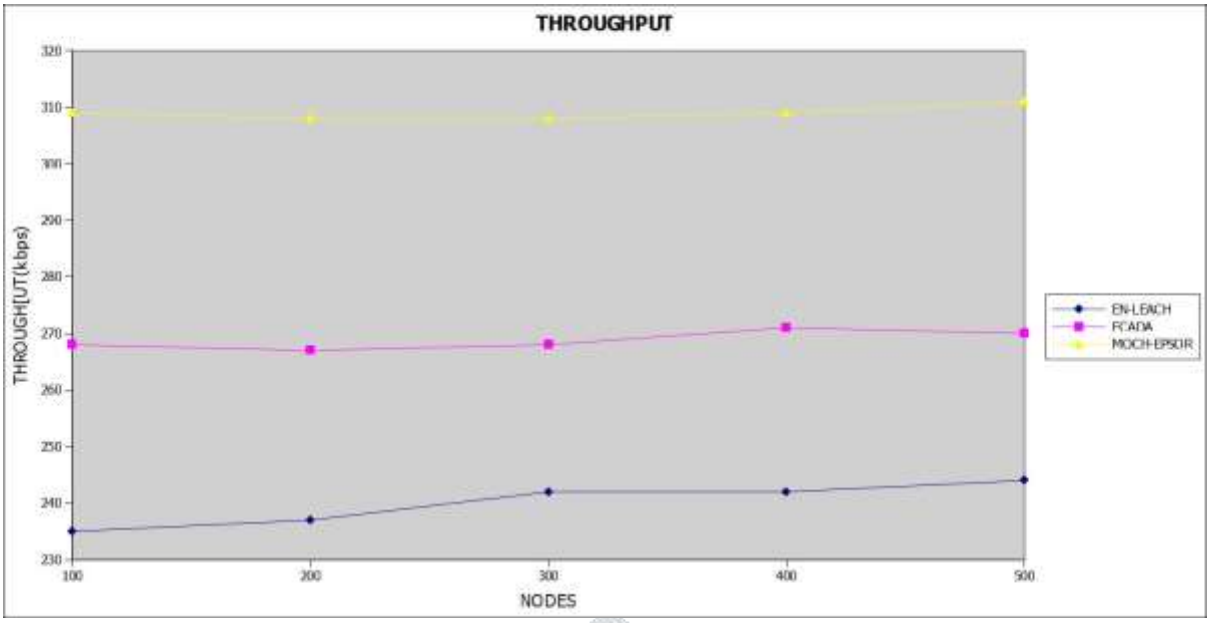

Fig 8: Throughput vs. Nodes

The above figure 8 results shows the simulation results of Throughput of both proposed & existing methods. Throughput is nothing but amount of data that can be transmitted between the sensor nodes. High throughput ensures the high amount of data delivery. The above listed table proves that the proposed method gives high throughput rate compared with existing methods.

Conclusion

In this paper, a multi-objective CH selection and multiple mobile sink based data aggregation scheme (MOCH-EPSOR) is introduced. This technique focuses on increasing the sensor network's lifetime, energy-efficient data aggregation, and CH stability based on multiple mobile sinks with the pattern of grid mobility. The major issues of coverage, link failure, and end-to-end delay are caused by the single mobile sink in larger sensor networks. Thus, the multiple mobile sinks are required to introduce. For improving CH stability, different multi-objective parameters like link quality, residual energy, communication cost, and node proximity have used that enhances the data aggregation. For identifying the optimized route between member nodes and the cluster head, a developed Particle Swarm Optimization (PSO) algorithm is embedded based on the modified fitness function for achieving energy-efficient data transmission. For data aggregation, the MS's moving along the clusters and remain in each cluster for certain time period. The experimental results proves that the proposed MOCH-EPSOR scheme improves the network lifetime and QoS than the previously proposed energy efficient protocols.

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