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AN ENERGY EFFICIENT CLUSTER HEAD SELECTION WITH OPTIMAL PATH SELECTION APPROACH IN WIRELESS SENSOR NETWORKS

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Abstract

Distribution of independent sensors can be termed as a Wireless Sensor Network (WSN) as it monitors the environmental or physical circumstances like pressure, vibration, sound, temperature and so on cooperatively. WSNs usually consumes less energy and has extremely long lifetime for network which are considered to be critical tasks, particularly in sensor networks involving of nodes which are observed to be lightweight and consumes constricted energy source. The Hybrid Energy-Efficient Multi-Path (HEEMP) routing is the preceding scheme modeled for wireless sensor networks. On the other hand, an appropriate selection methodology for CH possessing ideal skills is essential to stabilize the load of network lifetime and network's energy-efficiency. Here the cost of energy needed to choose a path for forwarding of data is alone taken into account. Besides, it doesn't learn about the quality of link to progress the ratio of packet delivery. So as to resolve this issue, the projected scheme modeled a Dynamic Binomial Distribution centered Glowworm Swarm Optimization algorithm along with Improved Link Quality Cost Function based data forwarding (DBD-GSO with ILQCF) methods. In the projected work of study, selection of Cluster Head (CH) is donebased on the transmission power, residual energy, node degree and minimum distance with the assistance of Dynamic Binomial Distribution based Glowworm Swarm Optimization algorithm (DBD-GSO). In order to exchange information with the cluster head inside the clusters, the nodes implement multi-hop routing technique. This technique after receiving of data packets from every member of cluster it transfers the data aggregated on the pre calculated track to the sink. The ideal path is selected in a way that the overall consumption of energy in the routing path is the least with high link quality and it is done by employing Improved Link Quality Cost Function (ILQCF). All the tests are carried by utilizing a simulator called NS-2. The projected and existing methods for detection are contrasted by means of features like throughput, end to end delay and consumption of total energy.

Keywords:

Multi-Hop Routing, Dynamic Binomial Distribution and Link Quality, Wireless Sensor Network

1. INTRODUCTION

In the modern era, the growing attention towards research is focused on Wireless Sensor Networks (WSNs), owing to its extensive range of applications comprising of military requirements for tracking, monitoring and border surveillance, intellectual schemes for transportation in observing density of traffic and conditions of road, and ecological solicitations to observe like water quality, atmospheric pollution, agriculture, and so on [1]. Wireless Sensor Networks (WSNs) is made up of huge quantity of sensor nodes (SNs), arbitrarily positioned to monitor and sense the environmental and physical circumstances [2].

A technique of finding a route among a destination (i.e., sink node) and source node for identified transmission of data is called as a routing protocol. The effectiveness of WSNs is vastly reliant on routing protocols which straightaway disturbs the lifetime of the network. The foremost aim of routing protocols is to enrich the lifetime of WSNs as well as reliability by bearing in mind the ability of a sensor node through the source constraints like power limitation, low speed processor and less band width for communication. Consequently, numerous scholars are now concentrating on modeling of protocols for wireless sensor networks that are power-aware. Irrespective of protocol for communication used, scholars should select the mode of communication such as multi hop or single hop. By employing a single hop communication mode every sensor dispatches its contents straight away to the base station. Whereas in multi hop mode every node dispatches its information intended eventually for the base station by means of nodes in-between [3]. The motive of various researches selecting a multi hop communication mode relies in the fact that it is estimated to consume less energy when compares to the single hop communication mode.

Owing to the wireless SNs compactness, constricted energy and power is offered; so there is a need for effective and competent exploitation of energy in WSNs. For conserving the sensor networks energy, clustering is confirmed to be the most competent method to be employed. To model any of the clustering schemes the network is initially separated into many groups named as clusters. Every cluster takes a front runner signified as cluster head. Inside the clusters, the one who is accountable to bring together the data from their member sensors [4]-[5] are called as cluster heads. Cluster head executes aggregation of data and eliminates the repetitive data and therefore decreases exhaustion of energy in the network. Yet the cluster heads absorbs higher energy owing to the added burden for accepting the data, aggregating it and conveying the data to the sink. This likewise has the consequence on the process of routing in an energy proficient way and that is the ideal objective of any WSN. Therefore, the appropriate choice of cluster heads acts as a significant part for preserving the energy and augmenting the WSNs lifetime. Selection of cluster head is an optimization problem and it is NP-hard.

Nevertheless, the suitable choice of CH [6-9] besides with optimum skills is essential to stabilize the energy-efficiency ratio of the network. Therefore, Computational Intelligence (CI) models with Artificial Immune Systems (AIS), Reinforcement Learning (RL), Artificial Bee Colony (ABC), evolutionary algorithms and few of the metaheuristic algorithms are employed for the process of clustering over the optimization problem of NP-hard.

2. LITERATURE REVIEW

The authors in [10] developed an energy conserving mechanism to reduce energy expenditure due to overhearing. To minimize energy, number of overhearing nodes is randomly selected based on probability. This probability based overhearing is integrated with AODV routing protocol.

Mao et al. [11] created an Improved Fuzzy Unequal Clustering (IFUC) Algorithm through WSNs. Thus, it stabilizes the consumption of the energy and long lasts the lifetime of the network. The developed approach depends on the systematic energy clustering method and inter-clustering routing protocol. These method makes use of fuzzy logic system to control each node's in forming as a group head and to calculate the radius of the cluster head by observing the local information of each node's namely local density, energy level and distance to the base station. Thus, the well-developed system makes use of Ant Colony Optimization (ACO) method to develop the energy-aware routine in cluster heads and also in the base station thus the energy consumption decreases and stabilizes the cluster heads and also clears the hot spot issues which occurs in multi-hop WSN routing protocol at a great extent.

Razzaq et al. [12] proposed an energy efficient Dijkstra-based weighted sum minimization routing protocol to WSN. Therefore, the above system offers a method to the cluster formation, where the K denotes clustering in the cluster formation phase and also computes the weight function to the cluster head selection process. With the channel conditions and radio parameters of the transceiver an optimal fixed packet size has been considered. By utilizing the Dijkstra Algorithm, the data transmission phase designs a multi objective weight function as a link cost. With the use of network this method acts as stabilized and capable energy consumption to the nodes. In the overall system, the simulation results make use of the structured plan by achieving the best performance with the terms of energy conservation. Moreover, this system points out large measurability and packet discharge rate due to the capable use of energy in the system.

Rao et al. [13] developed a Particle Swarm Optimization (PSO) depends on the capable energy Cluster Head (CH) choosing algorithm to the wireless sensor networks. Thus, the CH selection algorithm depends on the distance parameters and the unconsumed energy. In the beginning all the sensor nodes transmit their location and the leftover energy to the base station of the CH selection phase to examine whether it connects the threshold energy (minimal energy of the sensor nodes) which could be useful to CH. Thus, the CH selection algorithm depends on PSO is set to operate at the base station which is followed by the cluster formation phase. With the capable method of particle encoding and fitness process the algorithm has been structured. Moreover, the PSO approach utilizes the capable energy through enormous parameters such as intra-cluster distance, unconsumed energy of the sensor nodes and sink distance. Thus, the planned algorithm acts as a best tasking with certain conditions of total energy capturing, lifetime of the network then the countable packets of data through the base station

Huang et al. [14] created an energy-efficient multi-hop routing protocol depends on the grip grouping by ignoring the large struggles of cluster head that promote quick death of the nodes. By reducing the capturing of energy, the algorithm utilizes the electoral system through systematic nodes by joining different conditions likely stages of network area, node's location, node's energy. Communication nodes proposed through choosing cluster head nodes as well as it forwards data between clusters by the way of multi-hop routing, bearing the struggle of the cluster heads. Thus, the above discussed method has good tasking of efficiency with higher network area and energy stabilizing.

Thanamani et al. [15] proposed the Consolidate data gathering (CDG) based on compressed sensing (CS) theory for WSNs greatly reduces the amount of data transmitted compared with the traditional acquisition method that each node forwards the aggregate data directly to the next node.

3. PROPOSED METHODOLOGY

The projected technique with energy efficient routing scheme contains stages such as clustering and routing. Firstly the network is divided into numerous clusters by means of the sink. The sink elects the Cluster Heads (CHs) depending on the sensor nodes degree of transmission power, residual energy and minimum distance by utilizing the Dynamic Binomial Distribution based Glowworm Swarm Optimization algorithm (DBD-GSO). In the routing stage, ideal tracks are designated by employing Improved Link Quality Cost Function (ILQCF) to enhance the ratio of packet delivery.

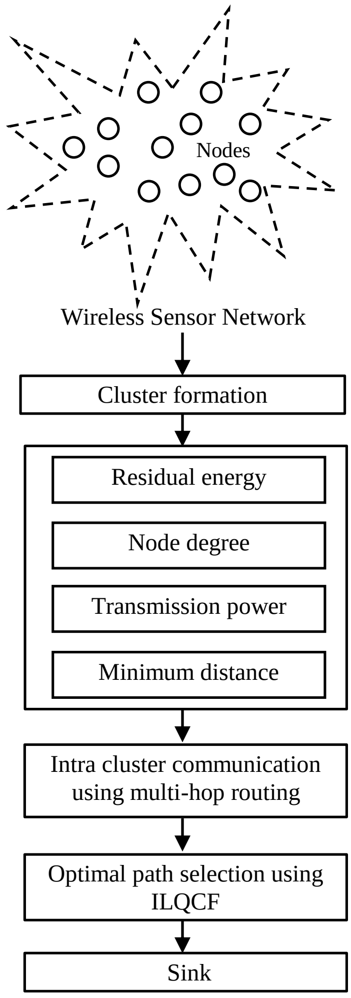


Fig.1. Flow diagram of the proposed system

3.1 NETWORK MODEL

In the model developed, it assumes that number of nodes which are arbitrarily installed in the terrain is N, and every node has a unique ID corresponding to it. A node is signified as i (its ID), and $N(i)$ is a set of neighboring nodes of i that are alive.

Assumptions

1. Sensor nodes are motionless and they are deployed in the terrain randomly.
2. A localization technique is used by the sensor nodes to know about their location.
3. Every node has the skill to aggregate data obtained from its neighbors.
4. The channel for communication is error free and reliable.
5. Only one Base Station or Sink is static which may be located at the corner or center or far from the terrain

3.2 CLUSTER FORMATION

The proposed scheme aims is to build clusters on the network. By means of neighboring nodes the initiator node will transfer the information of neighbor to the base station. For any source node the sensor node can forward the Nbr_Table data packet for only one time. To do this, every node preserves a list consisting of neighbors who have received the information. As the sink contains comprehensive information of topology, it picks the CHs depending on factors like transmission power, residual energy, node degree and minimum distance by employing Dynamic Binomial Distribution based Glowworm Swarm Optimization algorithm (DBD-GSO). Above all, the node will be straightly chosen as CH when it has the utmost Chance of Election (CE) parameter. The sink transmits the location and ID of node to all other nodes. Once the node accepts these messages from the sink, it directs the (Join_REQ) join-request message to the CH that is situated in the nearest. The above message comprises of the node's location information, ID and remaining energy. When the clusters are molded they employ multi-hop routing to communicate amongst the fellows of the same cluster with CH.

3.2.1 Objective Function:

So as to choose the ideal CH, the key factors of WSN like node degree, residual energy, transmission power and least possible distance are employed to achieve the efficient selection of cluster head. Cluster Head selection is done by using Dynamic Binomial Distribution based Glowworm Swarm Optimization algorithm (DBD-GSO).

Cluster Head selection using the following parameters:

- *Residual energy*: Thus, the maximum energy left over with the sensor node are higher through the lifetime. Thereby, left over energy with every node could be estimated in below equation:

Remaining energy (R_e) =Available Energy-Consumed Energy (1)

- *Node degree*: Degree of connection DV, Node (i), Time (t). Searching with every node nearby one's V (i.e., nodes communication area) where it specified through its degree in Eq.(2).

$$D_i=[|N_i|]= [n_i/(dis(i,j))<tx_{rang}] \quad (2)$$

Thus $i\neq j$, tx rang nodes area of the communication, distance (i,j) displays distance through nodes j and i.

- *Transmission Power*: Thereby the power capturing strategy of forwarding the data separated with two sensors are described in Eq.(3).

$$E_{TX}(k,d)=E_{elec}*k+\varepsilon_{amp}*k*d^2,\ d > 1 \quad (3)$$

Thus, energy capturing through the forwarding of data separated with two sensors are equivalent with the square through its distance.

With, k is the bundle of data that gets forwarded (bit), d has distance separates the two sensors, E_{elec} are power capturing through taking with data transmission through terms nJ/bit, ε_{amp} are power capturing stability through discussed radio coverage through condition of nJ/(bit*m^2).

- *Minimum Distance*: With each node, calculate the addition of distances through nearby ones. By the Euclidean distance formula, the distance through the nodes gets estimated in Eq.(4).

$$Dis_i = \sum_{i'\in N(i)} \{distance(i,i')\} \quad (4)$$

- *Weight Computation*: Estimate the joining weight

$$W_i = w_1(R_e)+w_2D_i+w_3E_{TX}(k,d)+w_4Dis_i \quad (5)$$

$$w_1, w_2, w_3 \text{ and } w_4 = 1$$

Thus, w_1, w_2, w_3, w_4 where the weighting indicators through similar strategically method. For particular circular area the node gets maximum weight and is chooses selected as a CH.

3.2.2 Dynamic Binomial Distribution based Glowworm Swarm Optimization Algorithm (DBD-GSO):

With these discussed searching work, Dynamic Binomial Distribution depend Glowworm Swarm Optimization algorithm (DBD-GSO) are utilized through the finite clustering head choosing. With GSO, thus the swarm of glowworms (countable of nodes) gets approximate forwarding through finding space (sensor network) through image system. Thus, the members with the glowworm method pick a luminescence resolution named luciferin through them. Every glowworm gets impressed through high resolution with each other nearby glowworm [16]-[17]. Thus, the glowworm finds various glowworm at nearby (nearby node), where it is placed through the present local-decision domain. Thus, the glowworms' luciferin intensity has been matched through the fitness through present locations [18]. At the maximum luciferin capacity, good location through glowworm where finding gap. Through every repetition, every location os glowworm gets varied, where the luciferin count (strong value) as well as go with the upgradation. Every repetition has a luciferin upgradation stage along with the changing phase depending through certain transition limits. Basically, GSO methodologies spitted with three stages:

- Movement phase
- Neighborhood range update phase
- Luciferin update phase

Luciferin-update phase: At its glowworm (node) location the luciferin gets improved and based with the fitness value. At the luciferin-update stage, every glowworm sums with above luciferin stages, thus the luciferin amount directly with the fitness through its present area through the objective system domain. As well as, thus fraction with the luciferin count gets subtracted to induce the decay through luciferin at its time. Where the luciferin mode upgradations restriction (objective method depending through the node) are provided through:

$$l_i(t+1)=(1-\rho)l_i(t)+\gamma f(x_i(t))$$
$$f(x_i(t)) = W_v$$
$$l_i(t+1) = (1-\rho)l_i(t)+\gamma W_v \quad (6)$$

Thus, $l_i(t)$ indicates Lucifer in stage managed through glowworm i with the t of time, q is Lucifer in decay stable ($0<q<1$), γ are luciferin improvement stability, then $f(x_i(t))$ indicates the count of objective system through agent i's places with the time t. Thus the important aim of the system is optimize through joint effect through approximate distance through sensors with a residual energy, cluster, transmission power, node degree.

Movement phase: At the time of stage movement, every glowworm (node decides, through use a probabilistic system, by forwarding through nearby which have a luciferin count (fitness value)maximum that of its own. It is the glowworms that get captured to nearby that glow at higher power (maximum fitness value). Thus, set of nearby through glowworm (node) i with time t gets estimated with below:

$$N_i(t)=\{j:\|x_j(t)-x_i(t)\| < r_d^j(t);\ l_i(t)<l_j(t)\} \quad (7)$$

Thus, $\|.\|$ indicates Euclidean norm system, $l_i(t)$ indicates luciferin stage (fitness value) merged through the glowworm (node) i with the time t, and $r_d^j(t)$ indicates variable nearby range mixed through the glowworm i at time t, where it gets surrounded through the previous with a sensor limit r_s ($0<r^i_d(t)\leq r_s$). Through every glowworm i, the approximate of moving toward a nearby j have provided by:

$$p_{ij}(t)=\frac{l_j(t)-l_i(t)}{\sum_{k\in N_i(t)} l_k(t)-l_i(t)} \quad (8)$$

Thus, $j\in N_i(t)$: Let glowworm i picks a glowworm $j\in N_i(t)$: through $p_{ij}(t)$ provided through Eq.(8). Thus, glowworm improvement gets denoted through:

$$x_i(t+1)=x_i(t)+s\left(\frac{x_j(t)-x_i(t)}{\|x_j(t)-x_i(t)\|}\right) \quad (9)$$

Thus, $x_i(t)\in R^d$ are the location through glowworm (node) i, with the time t; with the d-dimensional real space R^d, then the $s(> 0)$ are the count size.

Neighbourhood range update rule: Thus organized with every member gets managed through every agent (node) i through a nearby where the radial range $r_d^j(t)$ have dynamic with the nature. Where r_0 gets started neighborhood limit through every glowworm. By getting compactable improvement through the neighborhood limit update rule through the every glowworm (node), thus below rule gets implemented:

$$r_d^j(t+1)=\min\{r_s,\max\{0\ r_d^j(t)+\beta(n_t-|N_i(t)|)\}\} \quad (10)$$

where, β are stable one, r_s specifies sensory radius with the node i, then the n_t gets parameter by handling nearby count.

With the GSO fixed one, there is higher with the fixed count-size, every glowworm made up with a maximum jump (same to step-size). Thus, glowworms might forward as quick as possible with left over finite resultant with these updates. Though the count size gets limited, there is slow in convergence rate. Parallels it gets tough to think the more random step size. With the discussed work, thus the count for the step size is not yet fixed then the different glowworm through every repetition. Hence the countable size through glowworm are the members through update count, a variety binomial forwarding step count methodology gets well organized by functioning the maximum speed through prior area by finding and then enhancing the estimation perfectly through after stages with every findings. Thus the distribution of binomial through approximate different stages n and p indicates through the sum of n independent value that gets taken through the limit 0 or 1. Where the random through every variable gets taken value 1 which gets same to p, thus the mean through every variable have to be same to $1*p+0*(1-p) = p$. Thus the dynamic binomial distribution step size method have defined as in Eq.(11):

$$S(t) = npe^{-\Psi t}+\xi \quad (11)$$

Thus, Ψ and have positive factors, then ξ are a count with less-threshold.

With the starting initial step-size through Eq.(11) has to be same else mildly greater than the stable step-size in Eq.(9), with real-time step-size through Eq.(11) will be lessen that with the termination. Thus the amplitude and the probability of oscillation through the members of discussed DBD-GSO closer with the finite resultant will be lesser with fixed GSO. Specifically, where the parameter count get Eq.(11) selected in correct manner, thus oscillation gets be eliminated.

Algorithm 1: DBD-GSO

Step 1: Set number of dimensions = m

Step 2: Starting the count of glowworms (nodes (n))

Step 3: Set the generation G=1

Step 4: Let s be the count size

Step 5: Glowworms (sensor nodes) are randomly same distributed through finding space (sensor network)

Step 6: While (G < max generation) do

Step 7: for each glowworm (node) i do

Step 8: Lucifer in upgrades according to Eq.(6)

Step 9: Finalize the set of neighbors according to Eq.(7)

Step 10: Compute the probability of movement according to Eq.(8)

Step 11: Glowworm i moves toward j because Eq.(9); Executes the upcoming position $x(t+1)$ and proceeding decision radius $r_d(t+1)$ through every glowworm, then reuse next step-size using Dynamic Binomial Distribution step size using Eq.(11)

Step 12: Update neighborhood range due to Eq.(10)

Step 13: End for

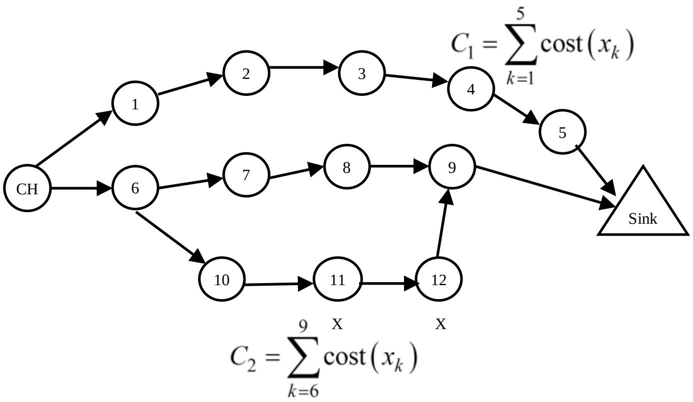
Step 14: End while

Due to the leftover energy, transmission power, minimum distance the optimal cluster heads, node degree, and have picked through using DBD-GSO algorithm.

3.3 OPTIMAL PATH SELECTION USING IMPROVED LINK QUALITY COST FUNCTION (ILQCF)

At one time the promoting the CHs, sink build up the routes distinguish the CHs then itself. Where the topological messages gets finished, it chooses the finite route likely the entire energy capturing through the routing way gets lessen through the link behaviors. Minimum permitted way are not as usual the good path where the routing through less way through the weak RF link behavior tends by maximizing packet reduction and then transmission again. The link reliability and then the network lifetime has more serious methods through the network by working with higher time, thus finite picking the way through routing the packets are the key through prolonged network life. The finite way picks through enhanced with the use of Improved Link Quality Cost Function (ILQCF). Thus the amount method has consisted link quality and then the costing of power.

Through every CH, by forming a Route Set (R) consisting through every accessible routes through CH and itself. Where they formed a Legitimate Route Set (LR) where it consist with these routes in which every nodes has the residual power through the predefined threshold. Basically, route has of many sensor nodes through taking charge of multi-hop communication by transmit packets with the CH to sink. Where the various routes have the sensor node (or nodes) where it have left over energy minimal than the predefined certain amount of value, have not added through LR set.



	***R*₁**	***R*₂**	***R*₃**
R	✓	✓	✓
LR	✓	✓	×
BR	✓	×	×

Fig.2. Through the sink the route choosing are done: R_1, R_2 and R_3 indicates through capable routes (R) through CH with sink. R_1 and R_2 gets enhancement through getting legitimate routes (indicates as LR) thus R_3 have not, the nodes 11 and 12 contain residual energies, minimal than threshold. Out of all legitimate routes, R_1 enhancement as best route (indicates as BR), since it contains the less energy amount value through maximum link quality

With every legitimate route, sink estimates the link behavior energy value. The addition through the energy cost of every node has the same with that route. Thus energy value through a sensor node is the proportion of energy spender through transmission (with the sudden nearby one) with the leftover energy through the node. Thus route where it have the minimum cost of energy through the link behavior have taken as good routing through sink and the CH.

$$\text{Cost}\left(LR_j\right) = \sum_{\forall x \in LR_j} \frac{TX(x)}{E_{res}(x)} + \frac{W}{LK(i,j)} \tag{12}$$

Thus, $LK(x,y)$ - indicates the joining behavior between x,y with the Legitimate Route Set and W - Data power through transmitting 1 bit through node.

Thus expected transmission (ETX) depending link behaviors gets calculated through below equation

$$\text{ETX} = 1/(df \times dr) \tag{13}$$

Thus, with the specific link the forwarded then the changing packet output ratio are indicated through dr and df.

Algorithm 2: ILQCF Strategy

Initialize R (Route set)
Initialize LR (Legitimate route set)
Initialize CH
for each CH do
    $R = R_1, R_2, R_3, \ldots, R_j$ (number of n available routes between CH and sink) $x_1, x_2, \ldots, x_i$ is in Route R
    for each route $R_j \in R$ do
        if $\forall x \in R_j$: $E_{res(x)} < E_{threshold}$ then
            $LR = LR \cup R_j$
        end if
    end for
    for each route $LR_j \in LR$ do
    Compute cost function
        $Cost(LR) = \text{Cost}\left(LR_j\right) = \sum_{\forall x \in LR_j} \frac{TX(x)}{E_{res}(x)} + \frac{W}{LK(i,j)}$
    if cost function $((C_1) < (C_2))$
        Select C_1 as the forwarder path
    else
        Select C_2 as the forwarder path
        $bestroute\ CH = min\ (cost(LR))$
        $BR = BR \cup bestroute\ CH$
    end for
    Return BR
end for
end procedure

Then getting the data through every nearby ones, CH tasks the calculated data then they transmits data through route getting with sink.

4. EXPERIMENTAL RESULTS

In this section, the Dynamic Binomial Distribution based Glowworm Swarm Optimization algorithm with Improved Link Quality Cost Function based data forwarding (DBD-GSO with

ILQCF) scheme performance is computed and contrasted with present Hybrid Energy-Efficient Multi-Path routing (HEEMP) system. The NS-2 simulator is used to conduct the experiments. The proposed and existing data forwarding approaches are contrasted in terms of throughput, end to end delay and entire energy utilization. The simulation settings are given in Table.1.

Table.1. Simulation Parameters

Parameter	Values
No. of Nodes	100
Area Size	1100×1100 m
Mac	802.11
Radio Range	250m
Simulation Time	60 sec
Packet Size	80 bytes

4.1 END-TO-END DELAY

The End to End delay can be termed as the time consumed by a packet to transfer from source to end through the network.

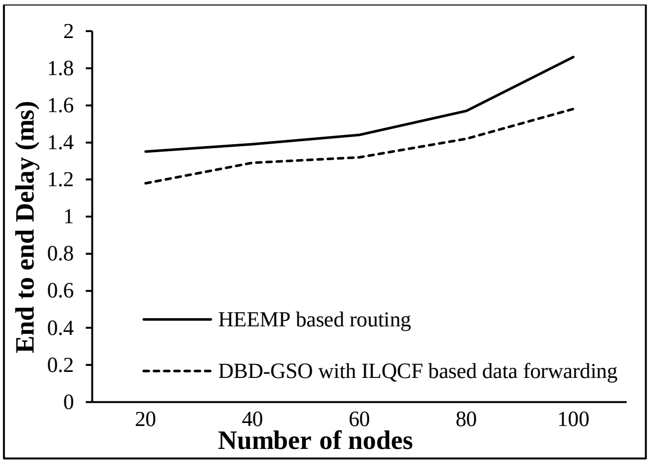


Fig.3. End-to-end delay comparison

The performance of the DBD-GSO with ILQCF centered data forwarding system is contrasted with the on hand HEEMP centered routing method in terms of End to End delay. When the quantity of nodes goes up the end to end delay also increases. The outcomes of the experiments demonstrates that the projected scheme achieves least end to end delay when contrasted with the on the hand HEEMP based routing protocol.

4.2 TOTAL ENERGY CONSUMPTION

Total energy consumption can be described as the total of the all nodes energy consumption in every round. Total Energy Consumption (TEC) can be presented as:

$$TEC=\sum_{Nodes}(E_{TX(Nodes)}+E_{RX(Nodes)}) \quad (14)$$

The total energy utilization of the projected DBD-GSO employing ILQCF centered data forwarding method is contrasted with the present HEEMP based routing protocol and it is exposed in Fig.4. The number of nodes is taken in x-axis and total energy utilization is taken in y-axis. In this projected work of study, depending on the node degree, residual energy, minimum distance and transmission power the most favorable CH are chosen with the assistance of Dynamic Binomial Distribution based Glowworm Swarm Optimization algorithm (DBD-GSO).Total energy consumption is diminished in the above method. From the Fig.4, it can be understood that the rate of energy consumption in DBD-GSO with ILQCF based data forwarding design is the lowest when compared to any other routing scheme.

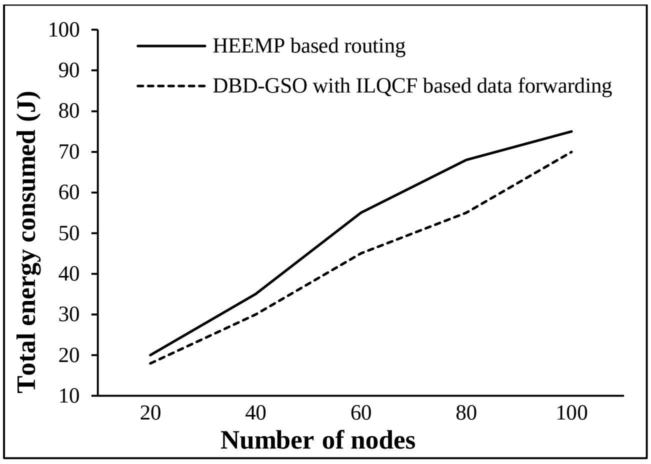


Fig.4. Total energy consumption comparison

4.3 THROUGHPUT

The throughput can be defined as the rate in which the data packets are profitably broadcasted over the communication links or the network. It is calculated in bits per second (bit/s or bps). It can also be characterized by units of data processed over a time slot specified.

Throughput = (Number of delivered packet *packet size)/(Total duration of simulation) (15)

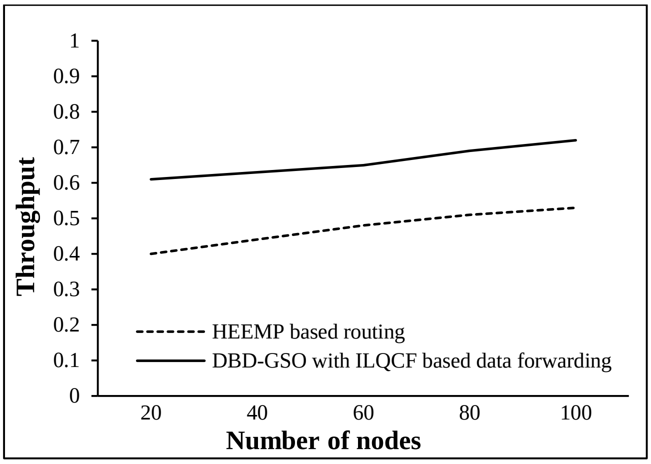


Fig.5. Throughput comparison

The Fig.5 illustrates the comparison of the throughput of the projected DBD-GSO with ILQCF based data forwarding method and the existing HEEMP based routing method. The number of nodes is taken in x-axis and in y-axis throughput is taken. In this projected research study, selection of most favorable path is carried out by employing the Improved Link Quality Cost Function (ILQCF). The cost functions comprises of link quality and remaining energy amid nodes. So it enhances the rate of throughput. The experimental outcome illustrate that the projected data forwarding method attains greater throughput when contrasted with the present system.

5. CONCLUSION

In this study, Dynamic Binomial Distribution based Glowworm Swarm Optimization with Improved Link Quality Cost Function based data forwarding (DBD-GSO with ILQCF) system is presented. So as to enhance the residual energy, transmission power, energy efficiency, node degree and minimum distance are taken into consideration for cluster head selection employing Dynamic Binomial Distribution based Glowworm Swarm Optimization algorithm (DBD-GSO). Within every cluster, nodes employ a multi-hop forwarding technique to converse with cluster head. In routing, Improved Link Quality Cost Function based path selection is carried out to attain proficient forwarding of data. The experimental outcomes proves that the projected scheme attains enhanced performance in terms of throughput, total energy consumption and end to end delay hen compared with the present Hybrid Energy-Efficient Multi-Path routing (HEEMP) scheme.

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