TELKOMNIKA Telecommunication, Computing, Electronics and Control
Vol. 23, No. 6, December 2025, pp. 1718∼1728
ISSN: 1693-6930, DOI: 10.12928/TELKOMNIKA.v23i6.27007

Escalating QoS by firefly optimization of CGSTEB routing protocol with subordinate energy alert gateways

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Article Info

Article history:

Received Feb 22, 2025
Revised Sep 23, 2025
Accepted Oct 19, 2025

Keywords:

Clustering
Firefly optimization
General self-organized tree-based energy balancing
Routing protocols
Subordinate energy alert gateways
Wireless sensor networks

ABSTRACT

Wireless sensor networks (WSNs) comprise large numbers of sensor nodes that are highly constrained by limited battery power, making energy-efficient routing essential for sustaining network lifetime and service quality. Among existing solutions, the general self-organized tree-based energy balancing (GSTEB) protocol with clustering has been widely adopted for energy-aware communication. However, GSTEB and its clustered variant often suffer from energy imbalance, high packet loss, and reduced quality of service (QoS) due to excessive load on cluster heads (CHs). To address these challenges, this paper introduces an enhanced routing framework that integrates firefly optimization with clustered GSTEB (CGSTEB) and introduces subordinate energy alert gateways (SEAGs). The firefly algorithm is applied to optimize CH selection through a fitness function that balances residual energy and node proximity, ensuring efficient cluster formation and adaptive load distribution. Meanwhile, SEAGs establish a two-hop communication model between CHs and the base station (BS), reducing CH energy consumption and preventing premature node failures. Simulation experiments conducted in NS2 demonstrate that the proposed firefly-CGSTEB with SEAG significantly improves QoS metrics, including network lifetime, energy utilization, throughput, and packet loss rate, compared with conventional CGSTEB. These results confirm the effectiveness of combining metaheuristic optimization with gateway-assisted routing for resilient and energy-efficient WSNs.

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1. INTRODUCTION

Wireless sensor network (WSN) has been utilized in diverse fields like the military, health care services, smart city, remote monitoring, industrial automation, and agriculture. In healthcare, sensor operation guarantees uninterrupted patient monitoring. In smart cities there is low-energy communication in traffic, environmental, and utility monitoring. Industrial automation and precision agriculture can leverage this protocol to maintain scalable, energy-sustainable sensor deployments, minimizing downtime and operational costs.

Furthermore, in critical domains such as military surveillance and disaster management, where real-time and energy-aware communication is vital, The network consists of many sensor nodes that closely monitor the physical and environmental conditions [1]. A sensor node collects, aggregates, and sends the environmental and physical information to base station (BS). Due to the finite node batteries, the network's lifespan will quickly deplete whenever data is transmitted [2], [3]. In most of the current protocols, multi-hop communication is assumed. It might generate energy hole problems, especially when sensor nodes (SNs) are close to the BS, including unnecessary transmission is overhead [4]. Numerous clustering protocols are proposed to avoid energy-hole problems and extend network lifespan [5], [6]. Some protocols based on energy-efficient routing played a significant role in enhancing the WSNs' operations [7], [8]. There are lot of routing protocol such as power-efficient gathering in sensor information systems (PEGASIS) is a chain based routing protocol, low-energy adaptive clustering hierarchy (LEACH) general self-organized tree-based energy-balance (GSTEB) is an tree based energy efficient routing protocols. The energy efficient clustering systems for WSNs is divided into two forms. The clustering systems enforced in homogeneous WSNs are called homogeneous clustering systems, and another one which is enforced in heterogeneous WSNs are called heterogeneous clustering systems.Here heterogeneous clustering system is used. In clustering techniques in WSNs focus on collecting data within groups of nodes, where leaders are elected from among them. These leaders, or cluster heads, are responsible for aggregating the data and transmitting it to the BS. In clustering, the network is divided into small groups. Each group chooses a single node as the cluster head (CH), and the everlasting will be a non-cluster node [9], [10]. Thus, clustering is a significant perception for consistently spreading energy convention and extending network lifetime in the WSN [11]. The election of the CHs plays a significant role in reducing the network consumed energy and their distribution overall in the monitoring area. For instance, the election of cluster heads proposed by the GSTEB protocol, [12], [13] is based on randomness, and cluster headcount fluctuates greatly. Figure 1 shows one arrangement of GSTEB clustering with a single hop to the base station [9], [14]. But GSTEB provides a strong baseline for energy-aware routing but fails to address multi-objective optimization, load balancing, and adaptability To enhance, the optimization techniques are utilized in much of the literature [5], [7]. These techniques focus on optimized routing in WSNs such as particle swarm optimization (PSO) ant colony optimization (ACO), and many others. But, one of the proposed protocols is the clustered GSTEB (CGSTEB) with optimization techniques [4]. As the name suggests, it forms a cluster based on a tree structure. The algorithms' main challenge is to elect cluster heads with the highest energy and close enough to other nodes to reduce the data communication distance [14]. So, PSO optimization, for instance, tries to achieve a node with the best global and particle best values. The global best indicates the current data particle close to the objective particle, while the particle best represents the contiguous molecule information that has ever gone to the objective. The main drawback of PSO optimization is that it is easy to fall into local optimum into high computational space, which affects the quality of service (QoS) [15], [16]. Our proposed work tries to overcome the drawbacks of PSO and investigates the effectiveness of applying firefly optimization [17], [18]. Firefly optimization introduces a more intelligent and adaptive mechanism for CH selection and routing.

The main idea of the optimal firefly approach is to keep away from the local minimum problem, and it will also transmit the data even though it is very noisy. The firefly heuristic is based on the light intensity produced by fireflies. The intensity of light produced is mapped to the objective function; hence, fireflies with low intensity are attracted to fireflies with higher light intensity. A hybrid version of the of the firefly algorithm, the synchronous firefly algorithm, is proposed based on the insect fireflies, which will produce light. Here insect fireflies, wherever a brighter sensor node in terms of energy and distance, will attract the less bright neighboring sensor nodes. Thus, the less bright sensor node can depend on the brighter sensor node for data transfer, saving energy. A fitness function has been designed based on the combination of two parameters, energy and distance, which decide the brightness of the sensor node [19]. But only at the low exploration capability of firefly, which is always in one direction, making it impossible at times to achieve optimal solutions. This can be solved by using complex problems, any function, or fractional order here. Because in the meta-heuristic firefly algorithm, randomly generated solutions will be considered as fireflies, and brightness is assigned depending on their performance on the objective function. When it moves for convergence, the algorithm is indirectly proportional to the number of fireflies. so it will run for several times till it reaches the convergent parameter set. If different results are obtained, it will be too high; it reaches non-optimal points. A slow convergent parameter set should be used, i.e., a larger number of fireflies and a greater domain size. If the same result is obtained again and again, but during a large fraction of the algorithm. Our proposed work overcome energy imbalance, high packet loss, and reduced QoS issues in traditional clustering-based protocols by intelligently selecting cluster heads and gateways. The next phase is data transmission, where data is transmitted to the base station through the CHs, which produces a heavy burden on CHs. Therefore, CHs energy might get depleted quickly. One of the solutions is proposed as in [3], it is a new subordinate energy alert gateway (SEAG) to be implemented, as shown in Figure 2. The gateway load is minimized when the load balancing scheme is allotted to sensor nodes. So, in this paper, the gateway technique is applied for data transmission. The reusable gateway node is inserted into the network since the gateway node is recharged based on the location details [20], [21]. Our main objective is to reduce the energy and increase the life span of the network. When it is deployed in a remote area, when data is transferred from source to destination, energy will be exhausted. To avoid this, our proposed work is done. The primary objective of integrating firefly optimization with SEAGs gateways for fast convergence , and also framework is designed to balance multiple QoS objectives such as energy efficiency, fault tolerance, and end-to-end performance ultimately enabling self-optimizing and resilient network operation. To avoid the depleted energy of CHs, they are exchanged in rounds where new CHs are chosen in each round. The CH is elected autonomously depending upon the position and distance of the gateway and base station. The nodes send their data to CHs, and CHs aggregate the received data and send the aggregated data to the base station. The cost of the gateway is less when contrasted with different nodes [21], [22].

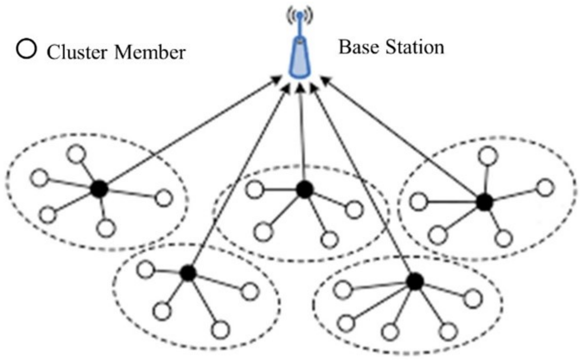

Figure 1. Clustering of sensor nodes

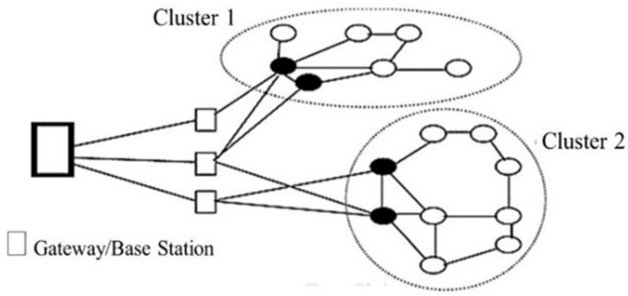

Figure 2. SEAG node with CGSTEB

2. RELATED WORK

The following part discusses the existing WSN, energy-efficient routing protocols, and optimization techniques utilized for such protocols. Several energy-efficient routing techniques encompass to increase energy, but satisfactory results were not found. For instance, Liu *et al.* [1] proposed an executive power scheme necessary for rotating inedible segments to make it possible with a specific time. Similarly, improved energy-efficient (IEE)-LEACH [2] is a clustering algorithm proposed to reduce energy consumption and prolong the lifespan of sensors. The limit of the proposed IEE-LEACH convention had several boundaries like initial, residual, total, and average energy so that it can pick up the system's power. Deepa and Rekha [23], the GSTEB was proposed in the direction to construct routing tree techniques everywhere in support of every single round, the BS assigned a root node and communicated to everyone. After that, every node elects its head by considering only the neighbor's information, making GSTEB a strong convention. Han *et al.* [17] evaluated the

GSTEB in terms of network lifespan and load balancing. Shah *et al.* [19] tried to develop a multi-hop cluster routing protocol, multihop-LEACH, that follows cluster intra and inter-multi-hoping. Sujae and Arulselvi [9] proposed in WSN there will be effective data flow among the nodes in the clusters. Here energy-efficient modified clustering (EMoC) algorithm was proposed for executes the clustering and cluster head selection. Wang *et al.* [20] developed there are other techniques that use group pattern and CH selection by PSO optimization, genetic algorithm has been expansively depending on CH selection techniques through multi intention utility taking into account power utilization along with packet delay. In 2020, shows that when we are using a triaxial (MEMS) accelerometer it is a low-cost sensor f which is used for measuring the acceleration. The values measured by the sensor are noisy and inaccurate. Therefore, calibration algorithms needs. In the case of an accelerometer, using the magnitude of the gravity vector as a stable reference leads to a nonlinear optimization problem. It is achieved by cuckoo optimization. But the drawback of nonlinearly optimization will increase the number of iterations. Ahad *et al.* [21] review the firefly algorithm's usage in various relevant domains. The authors accomplished that it can control multi-modal problems and have quick convergence and also confined look for heuristic. The authors of [24], [25] proposed that half convention low energy-aware gateway (LEAG). Gateway is utilized to limit the vitality utilization, and information is sent to the base station. It used Zigbee to diminish energy utilization and routing. Mehta and Pal [26] proposed an optimization technique, which is the formulation of determining the best solution for purposeful as well as valuable as possible for limiting or augmenting the parameters. PSO optimization easily falls into local optimum into high computational space so that it affects the QoS.

3. PROBLEM FORMULATION

Here, it is assumed that the sensor network is represented in the form of graph $G = (V, E)$ with a set of vertices $V = \{V_1, V_2, \ldots, V_n\}$ and edges $E = \{E_1, E_2, \ldots, E_m\}$. It is also assumed that each edge has a weight, see (1).

$$W_i = (W_{1i}, W_{2i}, W_{3i}, \ldots, W_{pi}) \quad i = 1, 2, \ldots, m \tag{1}$$

where W_{pi}, $p = 1, 2...$ is the weight of each edge p. $x = x_1, x_2, \ldots, x_n$ is identified using (2): with x being the current location:

$$\mathrm{x}_i = \begin{matrix} 1 & if \;\; E_i selected \\ 0 & otherwise \end{matrix} \tag{2}$$

The objectives were formed as:

$$z_1\left(x\right) = \sum\nolimits_{i=1}^{n} \mathrm{w}_1 x_i \tag{3}$$

The objectives were formed as:

$$z_2\left(x\right) = \sum\nolimits_{i=1}^{n} \mathrm{w}_2 x_i \tag{4}$$

$$Minimum \qquad z_p\left(x\right) = \sum\nolimits_{i=1}^{n} \mathrm{w}_n x_i \tag{5}$$

where, $Z_p(x)$ is the i^{th} objective to be minimized for the problem, where w_1 , w_2 , ... w_n are weighing parameters (normalized values), C denotes current node, i is the member and n denotes the number of members covered within the cluster. Here are three natures of administrative boundaries, packet loss rate, and one-way delay also remaining vitality is considered to manufacture the target work as a minimization.

3.1. Experimental

The experimentation contains various steps essential to carry out the intention:

Step 1: Setting up the network;

Step 2: Deploying sensors;

Step 3: Creating SEAG gateway node;

Step 4: Creating SEAG gateway node;

Step 5: Clustering GSTEB appropriately to estimate levels;
Step 6: Selecting CH and formation by utilizing the firefly optimization technique;
Step 7: Computing the sensor's energy level;
Step 8: Stopping.

3.2. GSTEB clustering algorithm

GSTEB is a tree-based routing protocol that uses clustering to group nodes and select cluster heads. Initially, nodes are grouped together to form clusters. The cluster operates in a circular round-based manner. For the formation of cluster GSTEB, one node will be elected, and it is compared with the threshold value $T(n)$, then CH nominated moreover it residue as a habitual node. The threshold is given as (6), where [*] is defined as a mathematical multiplication.

$$T(n) = \left\{ \frac{p}{1 - p * \left(r \bmod \frac{1}{p} \right)} if \;\; n \in G \right\} \tag{6}$$

3.3. Proposed framework for firefly optimization

The proposed algorithm leverages the firefly optimization technique to achieve efficient CH selection and energy-aware routing in WSNs. Firefly is a meta-heuristics algorithm that functions on the ordinary flickering light of fireflie where brightness and attraction guide their movement toward optimal solutions. By modeling light intensity as fitness values and updating positions iteratively, the algorithm ensures minimized energy consumption, balanced load distribution, and enhanced network lifetime. The elements of fireflies are as per the following:

(i) Every firefly can be engaged to another independent of the same gender.
(ii) The firefly's sparkle is compared with its attraction, and among pairs, which increasingly shines that will attract the one with minor brightness. A firefly will move randomly if it can't find any increasingly splendid neighboring fireflies.
(iii) Then, the scientific reproduction, the firefly's brilliance, depends upon goal work.

Mainly, it is a meta-heuristic capable of providing the finest solution to solve a multi-objective problem. By using the new fitness function, quality of services like energy, loss of packet, and overall delay from source to destination are given by:

$$F(x) = (P_{\mathrm{dr}}/P_{\mathrm{tot}}) \times (E_{\mathrm{r}}/E_{\mathrm{in}})\, e^{-e_{\mathrm{dl}}/e_{\mathrm{mx}}} \tag{7}$$

where, P_{dr} presents the number of packets dropped; P_{tot} indicates the total number of packets sent; E_r is the residual energy in node i ; E_{in} is the initial energy. e_{dl} is the end-to-end delay; e_{mx} is the maximum allowable delay. The cluster formation and CH selection in fireflies are given. In the firefly calculation (Mehta *et al.* 2017), the variety of light force and the issue's plan for engaging quality are urgent as the target work is encoded into it. The light power is determined to utilize γ ; the fixed light ingestion coefficient and the light force I can be figured dependent on separation r with the end goal that:

$$I = I_0 e - \gamma r \tag{8}$$

where, I_0 is the beam strength. The appeal β of a firefly is yielded.

$$\beta(r) = \beta e^{-\gamma r_2} \tag{9}$$

wherever β is the charm at $r = 0$. The space connecting pair nodes of fireflies be able to calculate by their Euclidean distance as:

$$r_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \tag{10}$$

A firefly i moves to a more attractive firefly j by:

$$x_i = x_i + \beta e^{-\lambda r_2} (x_j - x_i) + \alpha (\mathrm{rand} - 1/2) \tag{11}$$

In the proposed, it is categorized then the greatest one is elected as challenges. The elected one will replicate themselves by crossover and transformation. The new-fangled one is inserted into the group, and subsequently, iteration is sustained. Efficient data transmission is an important aspect of WSN. To transmit the data from BS will reduce the energy, so here we propose a SEAG to increase the energy between BS and gateway.

3.4. SEAG

To reduce the burden of the cluster head, A new novel-based SEAG is proposed so the cluster head close to the gateway will transmit the message and then transmit it to the sink. When the gateway node power is low, it can be rechargeable so that its cost is reduced. The time division multiple access (TDMA) time scheduled is calculated for each round. The distance is calculated between the gateway and the base station. The Zigbee is used to connect the nodes to the gateway. It also saves energy and reduces the cost of the networks. So the transmission and process should be good quality. As shown in Algorithm 1 and Algorithm 2, the proposed SEAG method integrates the firefly optimization and gateway-selection processes to enhance energy efficiency.

Algorithm 1 Firefly optimization technique

Input: Declare $x = x_1,\ x_2,\ ....\ x_m$
Let s be the primary population $x_i, (i = 1, 2, ...n)$
Output: The beam strength I_s on x_i be intent on
Process: Describe light inclusion coefficient γ
while ($s <$ Maximum)
  for $i = 1$ to n
    for $j = 1$ to i
      if then$(W_i > W_j)$
        {The movement of light emulation is between i through to j}
      end if
      {Charm diverges amid the distance r via $e^{-\gamma r}$; estimate new-fangled solution and bring up to date brightness strength}
    end for$j$
  end for$i$
  Ranking firefly along with getting the recent finest;
end while

Algorithm 2 SEAG gateway

Input: Distance and the place of the gateway node of coordinate (x, y) ; Let (n) be the threshold value;
Output: The result indicates that the space among gateway node and base station is calculated for expenditure reduction.
Process:
Begin
Sends an advisement message to the gateway node;
{ For every CH and gateway node,
If (CH == x && y) { locate $x = x_1$ and
If gateway node turns = false
The gateway node with locations x and y is indicated as x_2 and y_2;
{If it is a gateway node the space and the position are calculated as:

$$G(i,j) = \frac{s(i)\,E}{s(i)\,max} + d(i,j)\,x^2 + d(j,x)\,x^2\,\frac{d(j,s)}{d(i,s)} \tag{12}$$

}
else
Euclidean-distance between CH and gateway node is a nearer distance;
If nearer space < minutest distance
Current distances is now assigned to minutest distance
Cluster gateway node ID is assigned as a nearer gateway node to cluster-head;
else
gateway node turns = true;
}
End

3.5. Energy model

In WSN, a vitality model is intended to compute energy loss in every sensor node while communicating with other sensors. There are two types of communication channels: Two-way channel distribution and multipath channel for packet transmission by means of multi-jump are utilized here. Hence, the energy exhausted for transmission of packet over distance is determined by:

$$E_{tx}(k,d) = \begin{cases} E_{eleck} * k + e_{fs} * k * d^2, & if\,(d < d_0) \\ E_{eleck} * k + e_{amp} * k * d^4, & if\,(d > d_0) \end{cases} \tag{13}$$

where, e_{fs} is free space energy loss, e_{amp} is a multipath loss, d is a distance between source and destination nodes, and d_0 is crossover distance:

$$d_0 = \sqrt{\frac{\varepsilon_{fs}}{\varepsilon_{\text{amp}}}} \tag{14}$$

The energy spend by radio

$$E_{\text{RX}}(k) = k * E_{\text{elect}} \tag{15}$$

4. RESULTS AND DISCUSSION

The proposed firefly-CGSTEB with SEAG framework was evaluated using the NS2 simulator. The network was deployed over a 100 × 100 m² area with the base station fixed at coordinates (100,100). A total of 300 sensor nodes were randomly distributed to emulate realistic deployment. Each node was assigned an initial energy budget of 0.01 J. Communication parameters were set to a transmission power of 60 nJ/bit, reception power of 60 nJ/bit, and amplifier energy of 100 pJ.

To ensure statistical reliability, each experiment was repeated 30 independent runs, and the reported results represent the mean values with 95% confidence intervals. Standard deviations are provided in the performance tables, and statistical significance was confirmed using t-tests comparing the proposed approach with baseline protocols (conventional CGSTEB and Firefly-CGSTEB). Table 1 shows a range of the simulation parameters used by the NS2 simulator. These parameters, such as packet loss rate, one-way delay, energy consumption, and throughput, are shown as in Figures 3 and 4.

Table 1. General simulation parameters

Parameters	Values
Area of the network	100,100
Position of base station	100,100
Total number of nodes	300
Battery early power	0.01
Battery transmitter power	60 nJ/bit
Battery receiver power	60 nJ/bit
Transmit amplifier	100 pJ
Energy for aggregation	5 nJ
Max lifespan	200
Message range	2000 bits

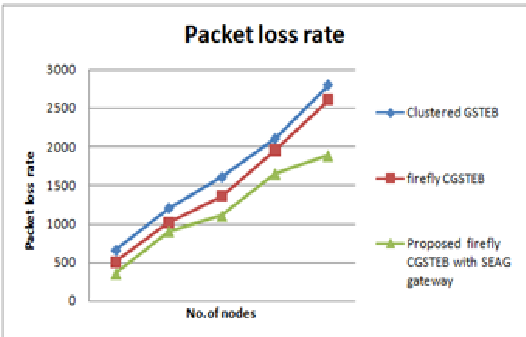

Figure 3. Packet loss rate

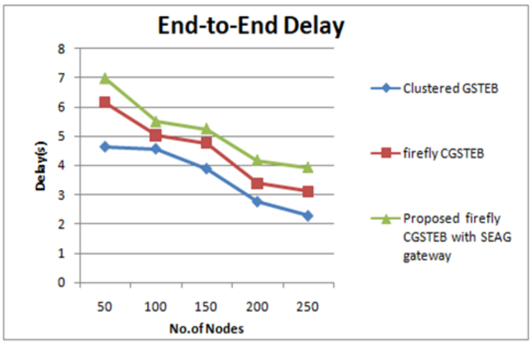

Figure 4. End-to-end delay

In the packet loss rate, the number of nodes is varied from 50, 100, 150, 200, and 250; with the packet loss, where the node increases, the packet loss rate is decreased. It denotes that the proposed firefly CGSTEB with SEAG gateway is more efficient when compared to the existing gateway. The packet loss rate of the proposed firefly CGSTEB with SEAG has 86% of lesser than the previous Firefly based CGSTEB. In Figure 4, end-to-end delay is the amount of occasion in use to broadcast a frame through the system from beginning to end. The number of nodes is varied from 50, 100, 150, 200, and 250 with the delay. Here where the node increases, the time taken to transmit the packet also increases. So, Figure 4 shows the proposed firefly CGSTEB with the SEAG gateway will be increased in time to deliver the packet from end-to-end nodes. The higher end-to-end delay in the proposed protocol is likely due to a combination of node increase, routing complexity, and possibly energy-efficient strategies. Despite this, the protocol is well-suited for applications where energy efficiency, reliability, or non-time-critical data transmission is more important than immediate data delivery. Finally, the delay of the planned move towards 90% higher than CGSTEB and firefly CGSTEB.

Observing Figure 5, energy consumption describes the entire quantity of energy inspired by the nodes to broadcast the frame. Here the energy varies in rounds. It is measured by Joules. Figure 5 represents the graphical representation of energy. When the round increases, the energy decreases. Here, the proposed firefly CGSTEB shows energy consumption. Here the graph X-axis represents the number of rounds and Y-axis represent energy measured by Joules. The illustration of energy for approach with different round consequences. It is accomplished that the energy consumption for proposed firefly CGSTEB with a SEAG approach of 89% is lesser than the existing. In the fourth experiment, we implement to evaluate the network throughput. The number of sensor nodes is varied from 50, 100, 150, 200, and 250. The simulation result is shown in Figure 6. In where, the number of nodes increases, the throughput will increase. Although throughput and delay have an inverse relationship, under some circumstances, both might increase at the same time due to a variety of causes including congestion, retransmissions, and network conditions. However, the throughput of our proposed approach is higher 76% than existing one.

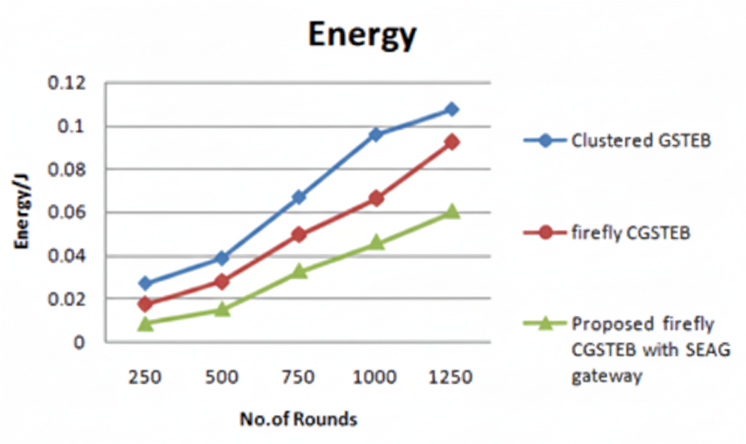

Figure 5. Comparison of energy consumption

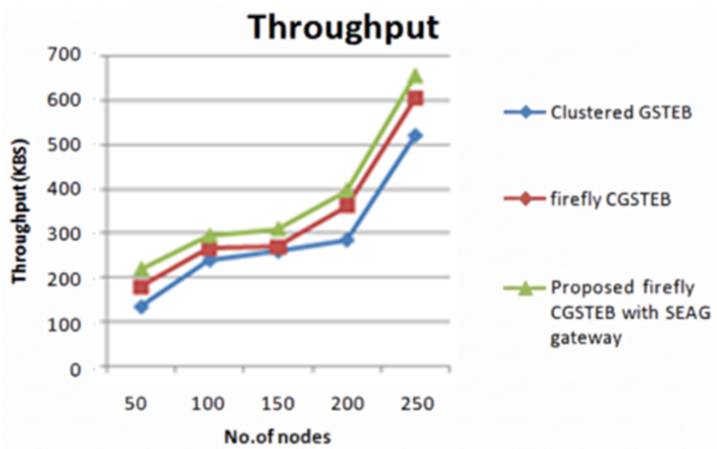

Figure 6. Comparison of network throughput

We summarizes the performance of the proposed Firefly-CGSTEB with SEAG protocol compared with CGSTEB, Firefly-CGSTEB, PSO-GSTEB, and LEACH. The results clearly demonstrate the advantages of our approach: packet loss was reduced by 86.2%, energy consumption decreased by 76.2%, network lifetime increased by 88.7%, and throughput improved by 72.4% relative to CGSTEB. These improvements are consistent across 30 independent simulation runs, with mean values and standard deviations reported. The substantial gains highlight the effectiveness of combining Firefly-based cluster head selection with SEAG-assisted routing, particularly in extending network lifetime and ensuring reliable data delivery.

Overall, the results confirm that the proposed Firefly-CGSTEB with SEAG framework substantially improves QoS metrics in WSNs. The improvements in packet delivery, energy efficiency, and lifetime are statistically significant and robust, while the increase in end-to-end delay represents a manageable trade-off depending on the application domain. This makes the protocol particularly well-suited for smart city monitoring, healthcare sensing, and industrial automation, where long-term stability and reliability are more critical than real-time response.

5. CONCLUSION

The clustering GSTEB is non-deterministic polynomial-time hard (NP-hard) in nature. Here integration of firefly optimization with the SEAG enhances the overall performance of WSNs by effective selecting the cluster head and formation of cluster for data transmission. Based on fitness value, firefly optimization selects the most suitable cluster heads and thereby it balances the intra-cluster energy consumption and prolonging network lifetime. The introduction of SEAG between the cluster heads and the base station reduces the communication head burden, reduces packet loss and delay, and ensures faster data transmission, leading to improved QoS compared to existing approaches such as clustered GSTEB and standalone firefly clustering. The key contributions of this study lie in optimizing energy efficiency, extending network usage, and achieving more stable data routing. Despite this, there are some constraints, such as the computational overhead of the metaheuristic optimization process and practical difficulties in real-world scenario. In the future, the focus will be on validating the approach through real-world testbeds and examining hybrid optimization methods to reduce complexity and strengthening SEAG nodes with lightweight security mechanisms to safeguard against potential vulnerabilities.

FUNDING INFORMATION

Authors state no funding involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal Analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject Administration
Fu : **Fu**nding Acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [N.T.T], upon reasonable request.

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