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A Hybrid Bird Swarm-Differential Search Methods, Based On Wsn For Trusted Cluster-Based Energy And Lifetime Aware Routing

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Abstract: Wireless sensor networks are the most frequent and necessary technology for transmitting, retrieving, managing, and tracking data. Routing protocols are an important aspect of WSNs. The routing protocol determines the most efficient path for data to flow from source to destination. Depending on the network, channel factors can cause different issues while choosing a route. Data flow, excessive energy consumption, storage space, latency, non-acceptance of traditional IP protocols, and node implementation are all examples of routing issues. To tackle these challenges during the routing protocol process, we propose a trustworthy cluster-based energy and lifetime conscious routing (TCELR) protocol for WSN that uses a hybrid bird swarm-differential search algorithm. Second, we include a cluster formation chaotic bird swarm optimization (CBSO) technique in the TCELR protocol. Second, the enhanced differential search (IDS) algorithm is used to determine each client's level of confidence in the cluster.The cluster head (CH) is known to be the highest confidence node in the cluster and performs intra-cluster routing as the sink node of cluster members; third, a scatter search based decision making (SSDM) technique is utilised to forward sensed data between multiple clusters for inter-cluster routing.The proposed TCELR protocol's efficiency is evaluated in terms of throughput, packet error rate, end-to-end delay, network lifetime, packet transmission ratio, and jitter, and the findings are compared to current state-of-the-art routing protocols.

Index: **TCELR, Chaotic Bird Swarm Optimization, Improved Differential Search, SSDM, Routingprotocols**.

1. INTRODUCTION

WSNs have been identified as one of the most significant advancements in the twenty-first century[1][2]. In recent decades, it has gotten a lot of attention from both academics and businesses all around the world. A WSN (Wireless Sensor Network) is made up of a number of low-cost, multifunctional remote sensor hubs that can be used for identification, remote exchange, and cabling. These sensor hubs communicate over a short distance and work together to complete a conventional mission, such as condition testing, military discovery, and new process management, via a remote medium. The basic premise of WSNs is that, while each individual sensor hub's capability is restricted, the system's overall strength is sufficient for the strategic requirements. There are a few apps that can be accessed by WSN sensor nodes. Sensor centres must be able to deal with themselves in a remote, self-governing manner once they have been submitted. Organize communication. Sensor centre points are battery-operated and require a rather significant amount of time to run without investment. The sensor is a crucial component of the device for observing genuine physical conditions in several areas, such as sound, temperature, humidity, force, friction, weight, acceleration, toxicity, and so on[5][6]. Sensor hubs have an impact on the likelihood of sensing, on-board processor for information handling, and conveying parts. Sensor systems that rely on a plethora of hubs for community-based activity[7]. Hubs in a remote sensor system's vitality, calculating force, and data transmission capability are lowered, resulting in a total steering convention approach for the remote sensor system. The steering structure of a remote sensor system has several important goals, including reducing vitality misery and optimising the system's life cycle.

It is necessary to develop routing mechanisms for transporting data between the sensor hubs and the base station[9]. The amount of unique characteristics with the way things are ludicrous to generate a worldwide tending to conspire with an enormous number of sensor hubs; all use of sensor frameworks frequently requires the surge of known data from multiple outlets to a specific BS[10] rather than ordinary correspondence frameworks. Different steering approaches for WSNs have been proposed, and these shows can be assigned according to various criteria. The steering agreements are validated using a defined trust-mindful management framework (TARF)[11] based on the distinctive attributes of the obliged asset, with the TARF strategy focusing on energy status and competence. A device coding-based probabilistic guidance (NCPR) plot in a clustered WSN delivers effective, accurate vitality while also reducing the problem of contact storms[12]. The information parcels are sent in a secure manner utilising a secured hub disjoint multipath guiding convention and the automated mark crypto framework[13]. The event's movement designs are discovered and controlled from the convention on vitality and activity conscious steering (EAR)[14]. EAR is a network-focused steering convention that selects the following hop hand-off hub: intervention concept detailed in the ATPG diagram and vitality equilibrium file. The in-organization conglomeration information steering system (DRINA)[15] is used to reduce the number of messages needed to build up a steering tree, the number of courses covered, the rate of aggregation, and the total and delivery of information that is reliable. The EHGUC-OAPR (EHGUC-OAPR)[16] synthesis of vitality that gathers inherited contradictory grouping and perfect flexible measure of execution steering was used to improve the whole system's usage of vitality and raise the proportion of information transfer productively. ALBA-R is a cross-layer merge throwing plot[17] that combines geographical path, impass care, MAC, warning snoozing booking, and sequential parcel transmission of information to provide a vitality-effective data collection method. Depending on the weight of the next bounce, a vitality-adjusted leading technique based on the forward-mindful component (FAF-EBRM)[18] is utilised to select the next bounce centre. Strong sensitive steering enhancement (R3E)[19] is utilised to strengthen the strength to link parts. It improves the strong and vitality effective parcel conveyance against the dubious remote links by utilising the varied neighborhood manner variety. Successful QoS-conscious GOR (EQGOR) picks and organises the sending competitor collection in a professional manner that is best for WSNs in terms of vitality competitiveness, dormancy, and temporal unpredictability[20].

2. RELATED WORK

A number of experiments were reported in the study on WSN routing techniques. Here's a quick rundown of a couple of recent studies.
To overcome the disadvantages mentioned, Zahedi et al.[21] proposed a routing protocol based on swarm intelligence (dubbed SIF). A fuzzy c-implies bunching calculation and appropriate group heads are employed to partition all sensor hubs into modified bunches. This technique can determine the exact number of bunches as well as certify the construction of modified classes over the scheme. The foundation table of fuzzy recommendations is visually characterised in fuzzy based research routing protocols, which is not suited for all implementations. A cross breed swarm insight estimation relies on fire to update the fluffy standard base table of SIF. The intricacies of the proposal can define the potential for happiness.
Zhang et al. suggested a vitality-adjusted clustering algorithm and an IRPL convention guiding approach.
[22] An IRPL steering convention was presented in this study to meet the vitality balancing requirements of remote sensor systems.The correspondence field is separated into equal zone rings in this guiding convention, which gives another control model for steering topology. Furthermore, ideal transmission hubs, perfect sending communication region, and ideal bearing edge are identified.Based on suspicion about the method's model, the bunching equation may be utilised to discover the optimum number of group heads. The bunching chance model and the hub rivalry system, as well as the group head centre in the remote sensor system, were employed to complete the grouping process.
Mohemed et al.[23] proposed on-gap youth reconnection (OHCR) with neighbourhood nature and on-gap warning (OHA) with global nature. The conventions ensure that all single arrangement phases are available; single-way coordinates efficiently for every topology by maintaining a critical distance from the overhead topology transformation.Proposed conventions outperformed ongoing conventions in terms of machine life, hub misfortune rate, and system overhead. On both the degree compelled tree (DCT) and the shortest way tree (SPT), the two conventions are evaluated to provide a half to seventy percent device lifetime extension over current routing protocols.
In terms of the usage of vitality during parcel transmission, Mohamed et al.[24] proposed the Degree Restricted Tree (DCT) guiding protocol. The hub degree, which enhances coordinating longevity, has been systematically extended to haphazardly dispersed DCT of homogenous sensor hubs. The best hub degree for promoting lifetime expansion and minimising breakdown vitality was found to be 3.The number of levels in the tree was calculated in terms of hub degree. The CDA steering convention, which is based on DCT with the optimal hub degree, is intended to give excellent device lifespan efficiency while

multiplying the soundness time frame and limiting the normal rate of vitality exhaustion in comparison to its peers.

3. PROBLEM METHODOLOGY AND SYSTEM MODEL

This part covers the problem detection of current WSN routing protocols and issues, as well as the solutions to the problems and the proposed device model.

3.1 PROBLEM METHODOLOGY

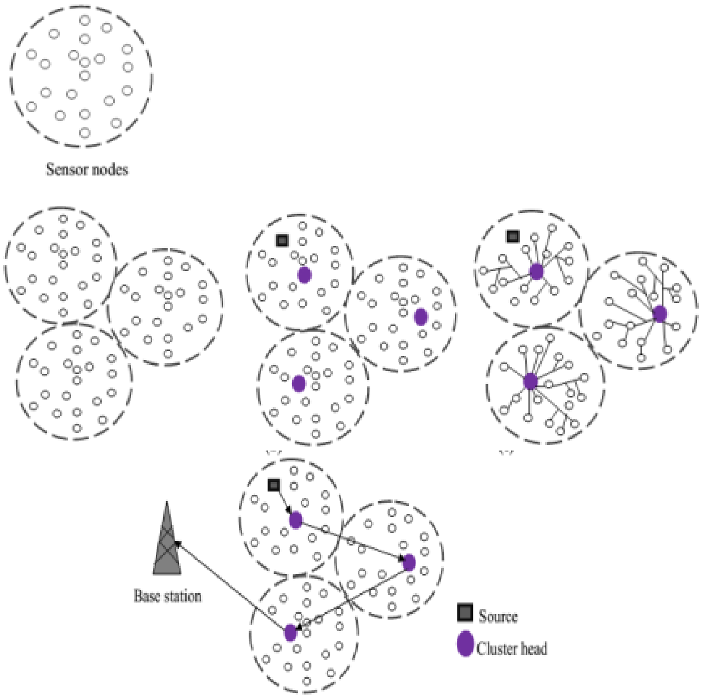
Tomar et al.[31] implemented the Energy Efficient Gravitational Search Algorithm (GSA), which is based on grouping along Hop and contains WSN-dependent routing protocols. Initially, GSA is used to select CH since its weight sensor hubs are connected to CH and the community is built in this manner.Using a fuzzy inference system, the super category head (SCH) is picked from among the CHs in the system (FIS). The data package from all CHs is assembled by SCH and sent to the sink or base station. The successful path is set up for transmission based on the hop tally of the sensor hubs.In terms of vitality performance, conveyance proportion, deferral, decrease, and throughput, the representation of this proposed GSA-FCR has been analysed and compared to that of current programmes such as GECR and PSOCR. WSNs have a wide range of applications that strategic targets pursue and monitor. Sensors, on the other hand, operate on limited power resources from [21] to [31].The use of these technologies has aided in the consideration of flow specialists in this way. The majority of available publications define the arrangement of lifetime as when the main sensor centre reduces much of its potency. In any event, the time isn't that essential. This is based on the assumption that if a sensor centre fails, the rest of the device will still work.

1. We propose a reliable cluster-based energy and lifetime conscious routing (TCELR) protocol for WSN using the hybrid bird swarm-differential search method. Initially, the TCELR protocol used a chaotic bird swarm optimization (CBSO) algorithm for cluster construction.
2. Second, the enhanced differential search (IDS) algorithm is used to determine each client's level of confidence in the cluster. The cluster head (CH) is the highest confidence node in the cluster, and it acts as the cluster members' sink node for intra-cluster routing.
3. Finally, a scatter search based decision making (SSDM) method is employed to forward sensed data between clusters for inter-cluster routing. The efficiency of the proposed TCELR protocol is evaluated in terms of throughput, network lifetime, end-to-end delay, packet transmission ratio, packet loss rate, and jitter, and the results are compared to the present state-of-the-art routing protocol.

3.2 SYSTEM MODEL:

The TCELR scheme is depicted in the diagram below. The sensor nodes are first clustered, then the head and source of the cluster are selected, as indicated by the chaotic bird swarm optimization (CBSO). We choose the cluster based on which node has high confidence scores (CH).We chose the cluster head using the enhanced differential search (IDS) algorithm that was suggested. The intra clustering routing of cluster members and cluster head (CH) is then formed. Intra clustering routing refers to data propagation within one cluster group between the cluster head and the cluster members (node).The inter cluster routing was then performed using the scatter search-based decision-making

(SSDM) strategy to convey the sensed data from the sink node to each cluster head to the sink node, the sensed data forward source. The destination is the sink node in this case.



(a) **(b)** **(c)** **(d)**

Fig.1 Proposed TCELR protocol (a) Cluster formation using CBSO (b) Cluster head selection using IDS (c) Intra cluster routing using IDS (d) Inter cluster routing for forward sensed data utilizing SSDM.

4. Trusted cluster based energy and lifetime aware routing protocol for wireless sensor network using hybrid bird swarm-differential search algorithms (TCELR)

4.1 Cluster formation using chaotic bird swarm optimization algorithm (CBSO)

The Chaotic bird swarm optimization algorithm is an example of a metaheuristic algorithm. This algorithm's initial position represents standard bird behaviour, whereas the last step represents chaotic bird behaviour. It is based on the behaviour of common birds. The initial behaviours are forage behaviour, flight behaviour, and vigilance behaviour. The chaotic acts are represented in the equation below.

Step 1. Initializing the parameters

We set the parameters of the algorithms; the virtual birds' positions are shown as X n t i1,...N at time step t; D is the dimensional space of gather food and fly.

Step 2. Initializing the population

Individuals as well as the global optimal are chosen at random, and the population is initialised using the equation below, which is also known as chaotic mapping.

$$\lambda_{n+1} = \eta \times \lambda_1 \times (1 - \lambda_1) \quad (1)$$

The first mapping behaviour of birds is described as 0,1,2,...and is in [1, 4]. If the average distribution of values between 0 and 1 is closer to 4, the system is entirely chaotic.

Step 3. Updating the population

The ideal people are updated in order to anticipate the current global optimal threshold. With the help of the equations below, you can understand this phase.

$$X^{t+1}_{n,m} = X^{t}_{n,m} + \left(P_{n,m} - X^{t}_{n,m}\right)\times C \times ran(0,1) + \left(P1_{n,m} - X^{t}_{n,m}\right)\times S \times ran(0,1) \quad (2)$$

This activity is also known as forging behaviour, where C and S indicate the social and cognitive accelerated coefficients, Pn,m represents the n-th bird's best past position, and P1n,m represents the sharing of the swarm's past position.

$$X^{t+1}_{n,m} = X^{t}_{n,m} + A_1\left(mean_j - X^{t}_{n,m}\right)\times ran(0,1) + A_2\left(Pk1_{,m} - X^{t}_{n,m}\right)\times ran(-1,1) \quad (3)$$

$$A_1 = a_1 \times \exp\left(\left(-\frac{P_{fit}}{sum\ fit + \varepsilon}\times N\right)\right) \quad (4)$$

$$A_1 = a_2 \times \exp\left(\left(-\frac{P_{fit} - P_{fit}}{\left|P_{fit} - P_{fit_1}\right| + \varepsilon}\right)\times \frac{N \times P_{fit1}}{sum\ fit + \varepsilon}\right) \quad (5)$$

a1 and a2 are constants in [0, 2] and smaller constant ε .

Step 4. Generating the temporary population

We can build a temporary population to calculate the fitness function using the formulae below.

$$V^{t+1}_{n} = X^{t}_{r_1} + F \times \left(X^{t}_{r_2} - X^{t}_{r_1}\right) \quad (6)$$

X1, X 2, and X 3 are the three persons chosen at random, and F is the scaling factor.
r1, r2, and r3 are not the same as i.

$$U^{t+1}_{n} = \begin{cases} V^{t}_{n,m}, ran(0,1) \le CR \ or\ j = ran(1,n) \\ X^{t}_{n,m}, ran(0,1) > CR \ or\ j \ne ran(1,n) \end{cases} \quad (7)$$

Where CR is in [0, 1]

Step 5. Comparing the population

We use formula (8) to compare the temporary population to the original population and then do the next optimal iteration.

$$X^{t+1}_{n} = \begin{cases} U^{t}_{n,m}, f\left(U^{t}_{n,m}\right) < f\left(X^{t}_{n,m}\right) \\ X^{t}_{n,m}, f\left(U^{t}_{n,m}\right) \ge f\left(X^{t}_{n,m}\right) \end{cases} \quad (8)$$

Step 6. Find final new fitness value

We can combine and assess fresh fitness values, as well as the global best, which can be represented by the equations below.

$$X^{t+1}_{n,m} = X^{t}_{n,m} + \left(P_{n,m} - X^{t}_{n,m}\right)\times C \times chaotic(map, range) + \left(P1_{n,m} - X^{t}_{n,m}\right) \times S \times chaotic(map, range), \quad (9)$$

$$X^{t+1}_{n,m} = X^{t}_{n,m} + A_1\left(mean_j - X^{t}_{n,m}\right)\times chaotic(map, range) + A_2\left(Pk1_{,m} - X^{t}_{n,m}\right) \times (2 \times chaotic(map, range) - 1) \quad (10)$$

The chaotic bird swarm optimization algorithm's procedure is depicted in the flowchart below. 2,

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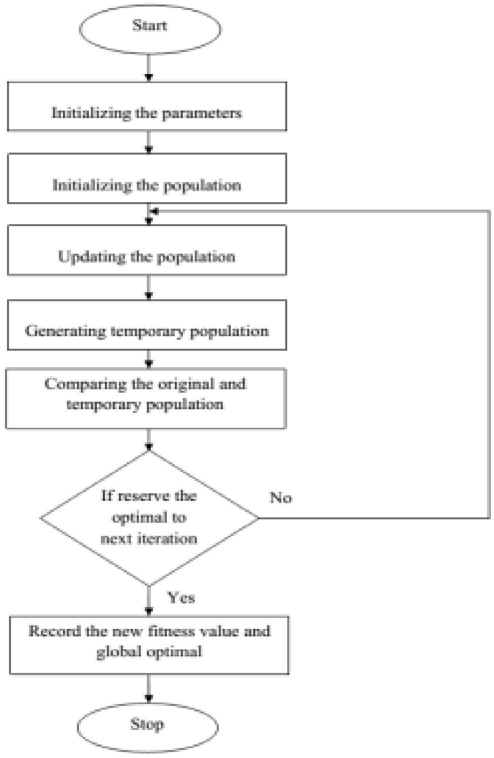

Fig.2 Process of CBSO algorithm

4.2 Cluster head trust degree computation **using improved differential search algorithm**
Many real-world issues can be solved with the modified differential search technique, including highly nonlinear, multimodal, and multivariable optimization problems. The major goal of this ISA is to create target and difference vectors using cross over, mutation, and selection vectors to create a new population. Here, we can obtain the mutant vector as a result of the mutation process.The following equation represents this process:

$$V_i, g = X_{R1,g} + F\left(X_{R2.g} - X_{R3,g}\right) \tag{11}$$

The following equation represents the current population (12),

$$V_{i,g} = X_{i,g} + F\left(X_{R1.g} - X_{i,g}\right) + F.\left(X_{R_2,g} - X_{R_3,g}\right) \tag{12}$$

Random integers R1, R2, R3 1,....., NP are used to pick R1 R2 R3. The distinct evolution amplification is represented by F. on generation g, the best individual vector is X best, and based on the search, we may improve the algorithm.

$$S_i, g = X_{R1,g} + scale.\left(X_{R2.g} - X_{R3,g}\right) \tag{13}$$

Individuals indicated by the following equation represent the current population of scale vector (14),

$$S_{i,g} = X_{i,g} + ran.\left(X_{R1.g} - X_{i,g}\right) + Scale.\left(X_{R_2,g} - X_{R_3,g}\right) \tag{14}$$

Individuals of artificial creatures whose size and location change are controlled by scale vectors.
Each scale has some values, which may change depending on the population and random processes.

$$Scale1 = rang(2 * ran) * (ran - ran) \tag{15}$$

$$Scale2 = rang(3 * ran) * (ran - ran) \tag{16}$$

$$Scale3 = rang(4 * ran) * (ran - ran) \qquad (17)$$

4.2.1 Computation of Fitness function

We can use the fitness function to assess the quality of each individual. We define the fitness function based on the violation of constraints and the optimization aim. The fitness function is defined using the equations below (18),

$$fitness\ function(X_i) = \begin{cases} F(X_i, l_t + 1) & if\ vcons(X_i \\ -\dfrac{1}{vcons(X_1)} & otherwisw \end{cases} \qquad (18)$$

Individual X I has broken a certain number of limitations. As a result, when numerous constraints are violated by individuals, the fitness values will be higher.

4.2.2 Operators of IDSA

We may search and adjust certain individual's dimensions and explore the new search region on the stopover site, which is an important function of IDSA. To avoid a blind search, we can include information from the stopover site operation's initial heuristic information, which can be expressed as the following equation (19) ,

$$OptimizationDirection = Currentoptsolution - subopt\ solution \qquad (19)$$

Current optimal solution is referred to as currentopt, whereas current sub-optimal solution is referred to as subopt.

The following equation represents an improved stopover site generation procedure (20),

$$X_i = X_i + F(V_i - X_i) + w.\begin{pmatrix} current Solution \\ - subopt\ solution \end{pmatrix} \qquad (20)$$

Where the weight factors w and F reflect the properties of random and guided searching, respectively. Individuals developed via various approaches are represented by Vi.

5. RESULT AND DISCUSSION

The proposed trusted cluster based energy and lifetime aware routing (TCELR) protocol for WSN is simulated using the Network Simulator (NS2), which employs a hybrid bird swarm-differential search method. Various testing scenarios with varied numbers of nodes and rounds are used to examine the routing protocol.The Chaotic Bird Swarm Optimization (CBSO) Algorithm, Improved Differential Search (IDS) Algorithm, and Scatter Search based Decision Making (SSDM) Algorithm are used in the proposed trusted cluster based energy and lifetime aware routing (TCELR) protocol approach for WSN. The Improved Differential Search and Chaotic Bird Swarm Optimization algorithms were compared to existing Gravitational Search Algorithms.Our proposed model assessed massive loads. The simulator randomly performs 400, 600, 800, 1000, and 2000 nodes in this case. On 1000m1000m network spaces, the nodes are done. The sensor nodes cluster using a chaotic bird algorithm and an improved differential search method, and the signal is forwarded to the cluster head.
During this process, the performance of sensor node parameters is analysed using the graph below.

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Table .1 Network Simulators of TCELR Settings

Parameters	**Value assigned**
Number of nodes	400, 600, 800, 1000 & 2000
Routing protocol	TCELR
Antenna	Omni antenna
MAC version	802_11
Packet size	512 bytes
Simulation time	60.000000
Rate of data	500 kb
Initial transmitting & receiving power	0.660w & 0.395
Network area	1000m×1000m
Radio Propagation model	Two ray ground

5.1 Performance Analysis

5.1.1 Throughput:

The throughput ratio defines the rate at which data packets are accepted at a destination in relation to the number of packets created by the source node over a certain time period.

$$Throughput\ Ratio = \frac{\mathrm{Re}ceived\,Data\ *8}{Data\ Transmission\ Period}$$

As shown in fig. 3, the throughput is slightly higher (TCELR) than the present method GSAFCR. As a result of this analysis, the proposed TCELR boosts and improves the throughput ratio. The comparable throughput value for 600 jobs is 43. The throughput value for 700 workloads is increased by 48, while the throughput value for 800 workloads is increased by 53. The comparable workloads for 900 workloads.Throughput numbers rise by 64 for 1000 workloads. When compared to the existing technique, the proposed TCELR protocol increased and improved throughput.

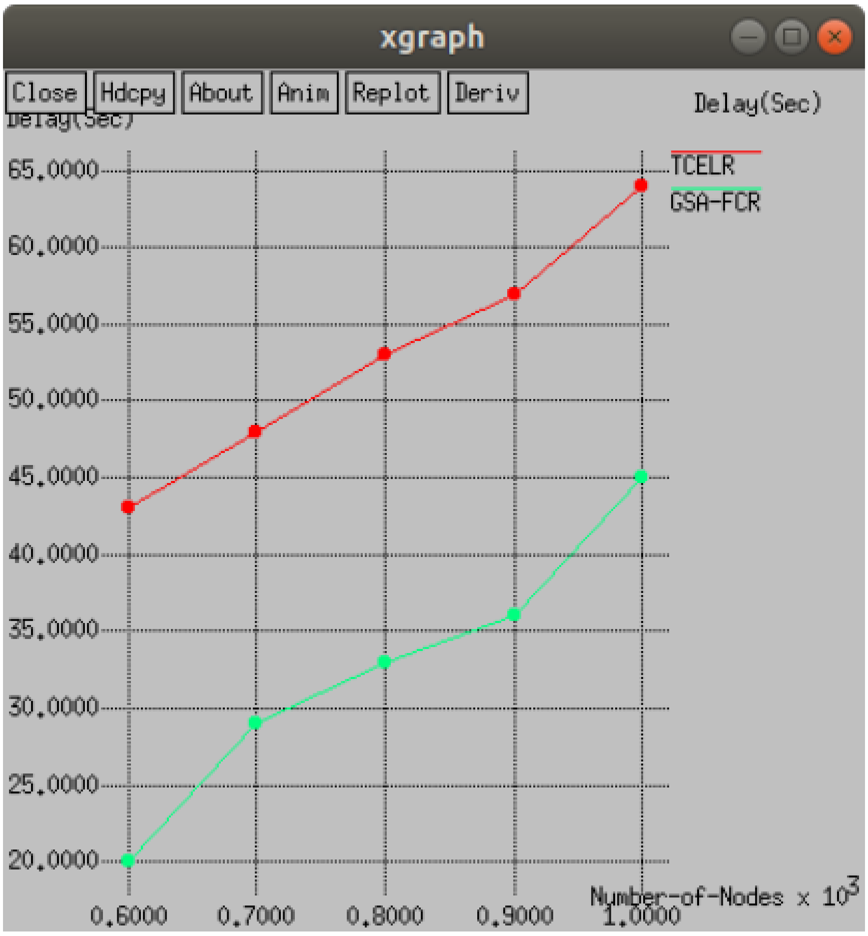

Fig.3 Number of workloads versus throughput

5.1.2 Network lifetime:

It is defined as a period of time during which the energy in the initial sensor has depleted. It's a crucial feature of wireless sensor networks. The comparable network life time for workloads 200,400,600,800,1000 is 50,45,42,39,37. When the strain on the network increases, so does the network lifetime. According to Figure 4, the network life time is increased by 80% to 90% when the proposed method is used.

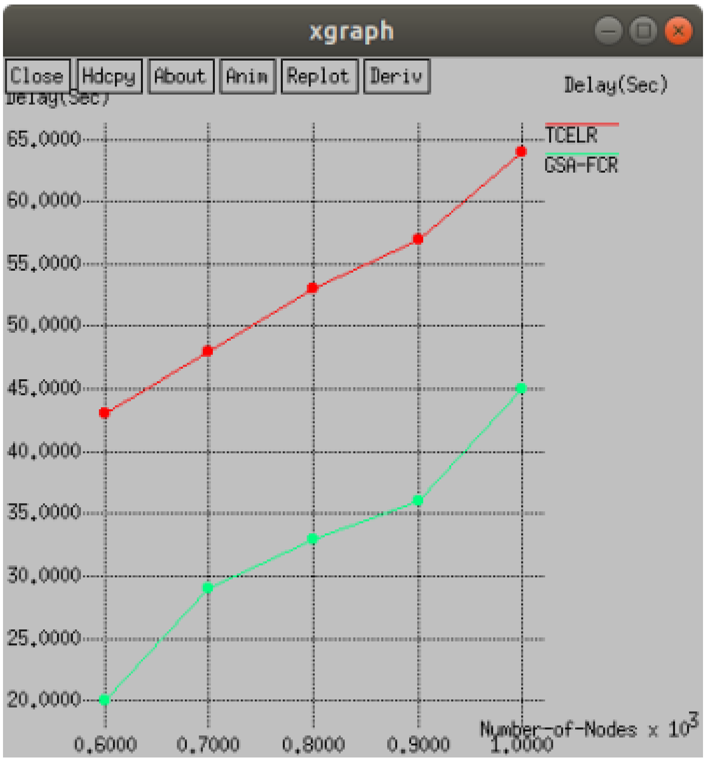

Fig.4 Number of workloads versus Network life time

The network lifetime in our proposed TCELR approach is longer than in the existing GSA-FCR method.

5.1.3 End to end Delay:

The one-way delay, often known as delay, is the time it takes for a packet to go from source to destination across a network. The following formula can be used to represent it:

The number N represents a link in a series, which is used to forward and store links. The transmission rate is R, while the packet length is L. The workloads are 200,400,600,800,1000, and the associated delay values are 30,27,25,23,22. As shown in fig. 4, when the workloads grow, the corresponding delay values drop, and the delay is minimised by applying the suggested TCELR. When compared to other approaches, the d

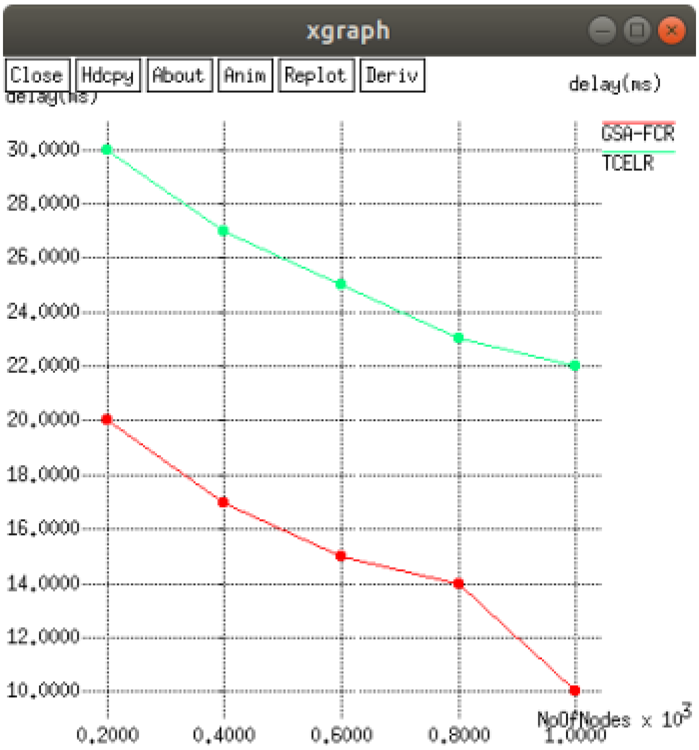

Fig.5 Number of workloads versus Delay

5.1.4 Packet Delivery Ratio:

The ratio among the packets received by destination and packets generated by the source.

$$PDR = \frac{Received\,Packets}{Generated\ Packets * 100}$$

By adopting the suggested TCELR protocol, the packet delivery ratio is raised by 99 percent. The initial PDR value is 70,72,81,89, and the final PDR value is 90 for given workloads of 200, 400, 600, 800, and 1000. When compared to the existing method GSA-FCR, the suggested TCELR provides a better and higher packet delivery ratio (PDR).

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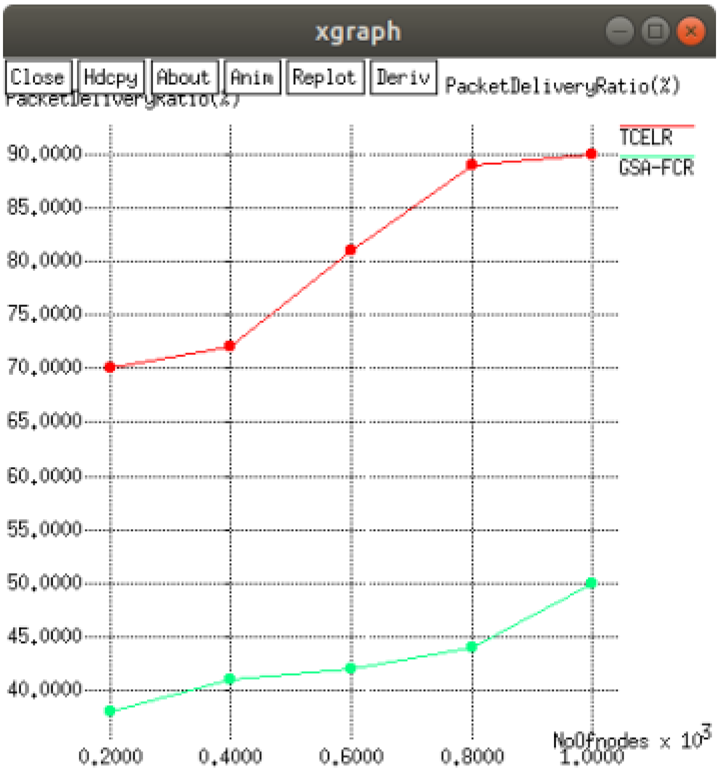

Fig.6 Number of workloads versus Packet delivery ratio

5.1.5 Packet loss:

During the passage of multiple packets, the network fails to reach the target. This is referred to as packet loss. Errors in network congestion and data delivery can cause packet loss.

$$Packet\ loss = \frac{no.\ of.\ received\ Packets\ not\ received}{Total\ no.of.\ packets}$$

For the first 200 workloads, the packet loss value is 45 percent. Finally, for 1000 workloads, the gain is 72 percent. The maximum packet loss values for 400, 600, and 800 workloads are 47, 55, and 63, respectively. According to fig. 6, the packet loss of the proposed protocol is 90 percent higher than that of the existing GSA-FCR.

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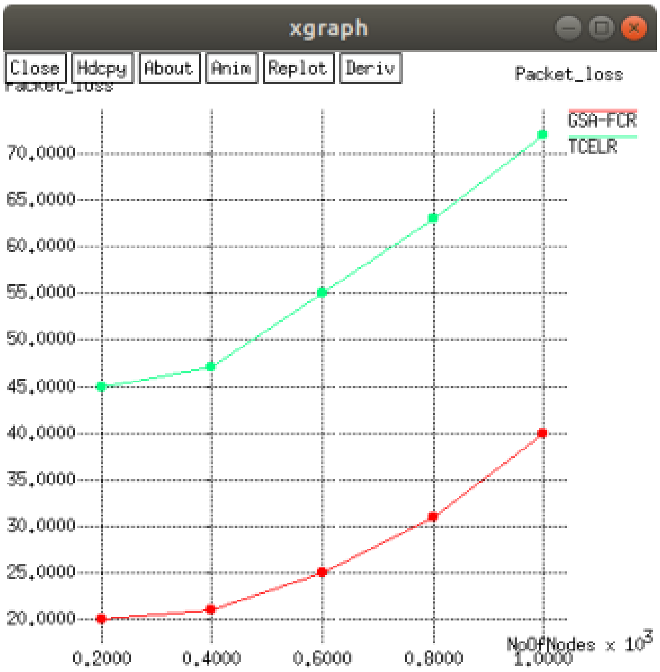

Fig.7 Number of workloads versus Packet loss

5.1.6 Jitter:

Packet delay variance is another name for it. The difference in time delay between data packets over a network in milliseconds (ms). The jitter can be determined using the formula below, using jitter values of 40, 50, 51,59, and 64 for inputs and workloads of 200, 400, 600, 800, and 1000. The jitter or packet delay variance has grown from fig.7.

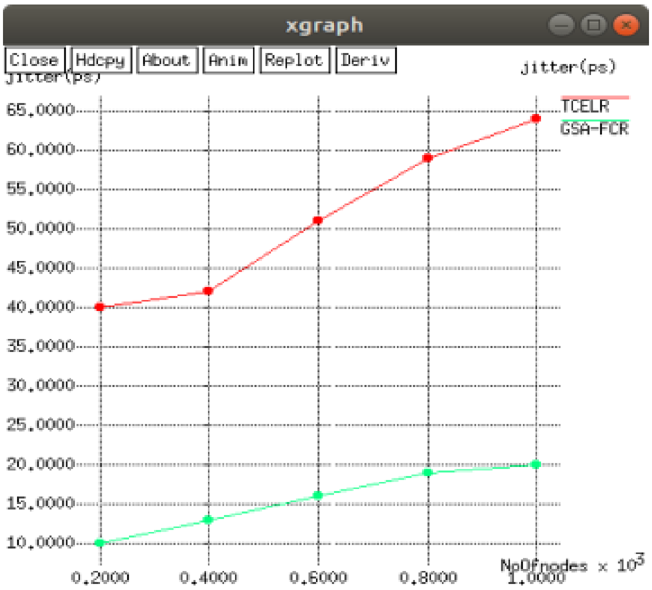

Fig.8 Number of workloads versus Jitter

In comparison to the present GSA-FCR, the jitter is somewhat increased from 50 percent to 90 percent.

6. CONCLUSION

We propose a reliable cluster-based energy and lifetime conscious routing (TCELR) protocol for WSN using the hybrid bird swarm-differential search method. Each node is clustered using the suggested Chaotic Bird Swarm Optimization (CBSO) Algorithm, and the Enhanced Differential Search (IDS) Algorithm is used to establish the confidence level of each cluster client.Then, for forward sensed data, we calculate the highest node of confidence (cluster head (CH)) and perform intra-cluster routing among the multiple clusters. Clusters using the Scatter Search-based Decision Making Algorithm (SSDM).The outcome and performance analysis of the proposed TCELR provides high reliability and eliminates the barriers of traditional approaches relative to current state-of-the-art routing protocols in terms of throughput, network lifespan, packet error rate packet distribution ratio, and end-to-end delay, jitter.

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