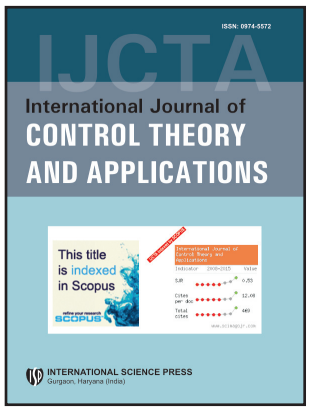

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Swarm Based Novel Energy Aware Clustering Algorithm for WSN in Realtime Applications

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Abstract: Wireless Sensor Networks (WSN) are infrastructures containing sensing, computing and communication elements that aim to give its controllers the ability to measure, collect and react to occurrences in the monitored environment. The network performance is still an issue in the WSN and an efficient protocol is introduced such as LEACH. To improve the stability, LEACH with fuzzy descriptors is used in preceding research. However the existing has drawback with effective cluster formation in heterogeneous WSN and also it is not achieved the Super Cluster Head (SCH). To overcome the above mentioned issues, the proposed system enhanced the approach which is used for increasing the energy consumption, packet delivery ratio, and bandwidth and network lifetime. The proposed research contains three phases such as clustering formation, Cluster Head (CH) selection, SCH selection. The clustering formation is done by Energy-Efficient Prediction Clustering Algorithm (EEPCA) in heterogeneous WSN. It is used to calculate the sensor nodes which have shortest distance between each node. Then CH selection performed by using Low Energy Adaptive Clustering Hierarchy- Expected Residual Energy (LEACH-ERE) protocol efficiently. It improves the energy consumption and reduced the delay rates between nodes. Apply Particle Swarm Optimization (PSO) based fuzzy approach to optimize the SCH in given network. PSO based fuzzy approach generates membership functions along with best particles (nodes) to select optimal node. It provides significant information and act as SCH which is focused to reduce the number of retransmissions unnecessarily. Thus it is used to increase the network lifetime, bandwidth, packet delivery ratio rather than previous approach and reduce the energy consumption, end to end delay, distance using PSO based fuzzy rules effectively. Hence the experimental result proves that the anticipated system LEACH-ERE with PSO fuzzy approach has higher network performance than the existing system.

1. INTRODUCTION

A wireless sensor network is distinct as a gathering of a huge amount of small low power, low cost and multifunctional sensor nodes which are haphazardly and extremely distributed either privileged the scheme or very adjacent to it [1]. Sensor nodes which are actually small in size comprise of a sensing unit, data processing unit, and geographic positioning scheme, power supply unit like battery or solar cell and communicating constituents such as radio organizations. It establishes the basis of a wide range of applications associated to national security, surveillance, military, health care, and environmental monitoring.

Usually, WSNs are closely organized in dangerous places where battery recharge or replacement is closely unbearable and human monitoring system is extremely risky. The outmoded routing protocols have numerous limitations when functional to WSNs, which are mostly owing to the energy-constrained nature of such networks [2]. Minimum Energy Communication Network [3] is a location-based protocol for attaining minimum energy for haphazardly organized ad hoc networks, which efforts to set up and preserve a minimum energy system with mobile sensors. It is self-reconfiguring protocol that preserves network connectivity in spite of sensor mobility. It calculates an optimal spanning tree rooted at the sink, named minimum power topology, which comprises only the minimum power paths from ach sensor to the sink.

In [4] an energy-efficient homogeneous clustering procedure for wireless sensor networks in which the duration of the system is enlarged by guaranteeing a homogeneous distribution of nodes in the groups. In this clustering algorithm, energy efficiency is dispersed and network recital is enhanced by choosing cluster heads on the root of (i) the residual energy of prevailing cluster heads, (ii) holdback value, and (iii) nearest hop distance of the node.

Clustering maintenances diverse communication pattern corresponding one-to-one, one-to-all, one-to-any, one-to-many, and many-to-one. For the cluster grounded wireless sensor network, the cluster information and leader election (called cluster head, CH) are the rudimentary concerns. The leader of cluster organizes the communication amongst the cluster members and accomplishes their data. Cluster grounded WSNs categorized into three broad group namely (i) homogeneous sensor networks, (ii) heterogeneous sensor networks, and (iii) hybrid sensor networks. In homogeneous sensor networks, all the sensor nodes and base stations are indistinguishable in terms of hardware competence and preliminary battery power. In this technique, the static clustering selects cluster heads (CH) only once for the complete epoch of the system. This outcomes in excess on cluster heads. As anticipated in Low-energy adaptive clustering hierarchy (LEACH) [5], [6], the part of cluster heads is haphazardly and occasionally alternated over all the nodes to guarantee the similar rate of indulgence of battery power for all the sensor nodes.

The LEACH-ERE algorithm [7] practices two descriptors: residual energy and predictable residual energy (ERE) of the sensor nodes for scheming the accidental value with fuzzy logic. The superior casual earnings that the node has more coincidental to be a CH. So as to approximate the ERE, the expected energy consumption (EEC) is mandatory. ERE in apiece round is alteration amongst node residual energy and node EEC. In this process, the amount of groups is secure and strong-minded at the start of networking.

In [8] illustrated the swarm optimization to discover optimized position of cluster head (CH) with the aim of decreasing the complete energy ingesting throughout packet transmission to descend. Particle Swarm Optimization (PSO) is a method which is recognized for its informal execution and fast convergence. Added, we examine the result of link failure possibility on transmission of packets and originate predictable amount of retransmission above a path in the sensor network. The PSO eventually decreases the communication distance by finding optimal location of the cluster head nodes in the group.

In this research, LEACH-ERE algorithm is proposed and this is used to select the CH on WSN. The predictable/projected residual energy is cast-off in cluster head selection for wireless sensor networks are also estimated. Particle swarm optimization (PSO) based fuzzy method is proposed to elect a super cluster head (SCH). The rules of fuzzy approach are gets optimized using PSO algorithm.

2. RELATED WORK

Sun et. al., [9] suggested a numeral group formation protocols have been anticipated newly. This research is familiarized secure distributed cluster formation protocol to establish sensor networks into equally disjoint groups. This procedure has the subsequent possessions: (1) normal nodes are alienated into equally disjoint groups;

(2) all the normal nodes in individual clique approve on the similar clique memberships; (3) although peripheral attackers can be prohibited from contributing in the cluster formation procedure, privileged attackers that do not trail the protocol semantics can be recognized and detached from the system; (4) the communication directly above is modest; (5) the etiquette is completely distributed.

Heinzelman et. al., presented [10] LEACH protocol for better energy consumption. This etiquette forms clusters grounded on the acknowledged signals and by means of distributed procedures. Nodes make decisions deprived of concentric control self-sufficiently. With the intention of balance the energy ingesting to each node, in each round, all clusters have the occasion to convert the cluster head. In this etiquette cluster head nodes are cast-off as route finders (to the base station). All data processing, certain data buildup and amalgamation in every cluster are achieved close by.

Lee et. al., presented [11] LEACH which is most efficient for CH selection in a probabilistic means and attempts to poise the load at apiece sensor node in a rotation base. Nonetheless numerous studies extant the competence of LEACH protocol, it has definite drawbacks that necessity to be deliberated. As LEACH trusts on probabilistic value, it influence occur that in every round more than one cluster heads are designated or no cluster head is designated. Added, the cluster head may be designated at the border of the network which aims to the indecorous energy distribution. LEACH also does not reflect the distribution of sensor nodes and residual energy of apiece node after conclusion of separately round.

Lee et. al., [12] anticipated a fuzzy logic grounded clustering method which trails the LEACH method for cumulative network lifetime. Predictable or projected residual energy is cast-off as a key factor to first-rate cluster head for consistently allocating the capability in wireless sensor networks. It cast-off the fuzzy inference schemes in every node for constructing computation. They are not allowing for optimal fuzzy set in grouping cycle comprising cluster formation period and data communicating phase.

Anno *et. al*., [13] two fuzzy grounded schemes for choosing cluster head in WSNs. They intended Fuzzy grounded CH Selection schemes which deliberating three input linguistic factors like Remaining Battery Power, Degree of Neighbor Nodes and Distance from Cluster Centroid to originate CHs. This scheme is not appropriate for large scale WSNs.

Particle swarm optimization (PSO) is a modest, actual and well-organized optimization algorithm. PSO is cast-off to search the search place. It is tranquil to tool and it can be functional for both scientific research and engineering practice. In PSO, a global fitness function is cast-off by all the elements in the swarm. In this, No overlapping and mutation scheming rapidity is very dissolute. It estimates the suitability of every particle. It inhabits the superior optimization capability and it whole effortlessly. Particles in outdated PSO characterize the candidate solutions to a lone optimization problem [14]

3. PROPOSED METHODOLOGY

In the proposed system, the method introduced named as LEACH-ERE procedure for effective cluster head selection procedure. The proposed architecture diagram is shown in the Figure 3. The proposed research contains the phases such as cluster formation, cluster head selection, super cluster head selection.

3.1. Clustering formation

3.1.1. System Assumption

In the anticipated replica, sensor nodes are measured to be organized haphazardly to observe the environment unceasingly.

1. All the sensor nodes are stagnant apart from the base station
2. The base station is mobile
3. Heterogeneous networks have been measured such that all the sensor nodes have preliminary identical energy.
4. The distance amongst the node and the base station can be calculated grounded on established signal strength

3.1.2. Heterogeneous Wireless Sensor Network (HWSN)

Heterogeneous WSNs are acquisition significance in current years. Complex problematic situations entailing of diverse environmental circumstances necessitate exact sensor nodes for the separate tasks resultant in heterogeneous networks. In homogeneous network all the nodes are indistinguishable so as to battery energy and hardware difficulty. Homogenous networks have pure static clustering. But the most important drawback of homogeneous sensor network in addition to role rotation is that all network nodes will be able to act as cluster heads, and hence they should posses the required capabilities related to hardware requirements. To overcome the above mentioned problems, the heterogeneous network is presented in this research. As the altered sorts of sensor nodes may be mismatched, added common management construction for these heterogeneous surroundings is a requirement [15]. The sensor nodes might have diverse sensors for observing the situation. All sensor nodes of one kind are capable to connect with per capita other and form a sensor subnet.

In heterogeneous sensor systems, characteristically, a huge amount of low-priced nodes achieve sensing, although a uncommon nodes having moderately added energy accomplish data filtering, fusion and transport. This chiefs to the investigation on heterogeneous networks where two or added kinds of nodes are measured. Heterogeneity in wireless sensor networks can be cast-off to extend the life time and dependability of the system. Heterogeneous sensor networks are prevalent, chiefly in real distributions as labelled [16] [17].

In this research, a novel heterogeneous sensor networks perfect with heterogeneity of examined objects and energy heterogeneity of all nodes is anticipated. For the heterogeneous networks with certain possessions, in order to create added rational usage of network vitality and extend the lifetime of the networks, this investigation offers an Energy-Efficient Prediction Clustering Algorithm (EEPCA).

EEPCA gets informed of the mutual distance between nodes through broadcasting in the initial stage of nodes clustering. It regulates node energy issue by associating the energy of a node with the normal energy of other nodes within the communication assortment and regulates communication cost issue rendering to the proportion of the usual energy used up in one communication outside all nodes and the model usual energy ingesting subsequently the node converts the cluster head. The possibility for nodes to convert cluster heads is unswervingly associated to energy feature and communication cost feature. All nodes in the networks take turns as cluster heads to achieve uniform energy consumption. So as to protect energy expended by distribution energy data in every round of nodes grouping, an energy predication archetypal is reputable for nodes whose information gathering (such as temperature, humidity, etc) is of consistency in time interval and message length. In view of the vicissitudes in networks situation and mistakes amongst intended and definite node energy ingesting, set the nodes do not essential to transmission their energy data if the alteration amongst the node residual energy in the preliminary phase at the present round and the predicted value at the last round is within a certain range.

To encounter the hassles of well-organized environmental observing, we designate our HWSN typical with both diverse preliminary vitalities and observed objects. The rudimentary expectations of networks replica: the networks is situated in a $M \times M$ square area (Figure 1), N sensor nodes are haphazardly distributed inside the

networks, nodes are somewhat moveable or still, and base station is situated in the medium of the area. The networks achieve the job of environmental observing and sensor nodes observer a diversity of objects. Describe nodes monitoring temperature, humidity, wind direction etc. as regular data acquisition (RDA) nodes; these nodes direct back messages of fixed length at a fixed interval; nodes observing fire are not steady in obtaining information and the messages sent back are not steady.

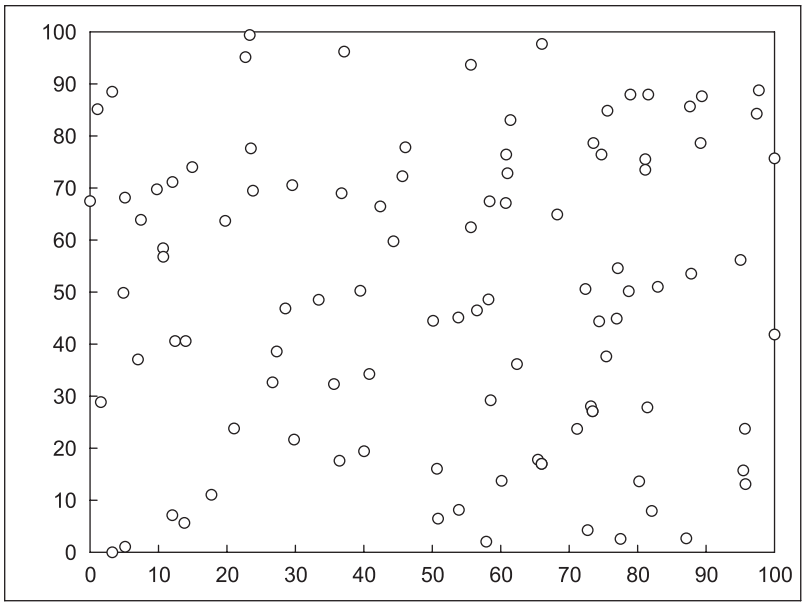

Figure 1: Random heterogeneous network

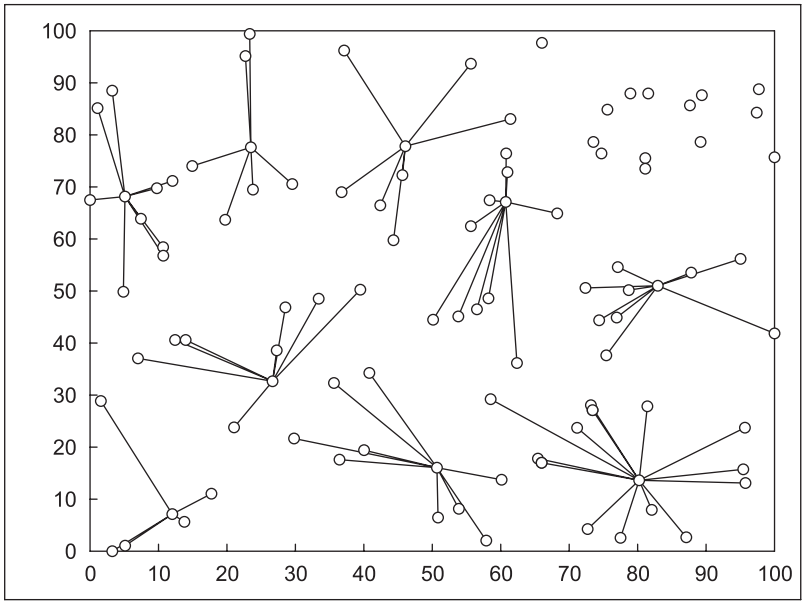

Figure 2: Cluster formation

Therefore, nodes are heterogeneous in two methods: (1) heterogeneous data-acquisition -regularity: some nodes are steady in obtaining information and some are not. All regular nodes direct bits; $n_1 \sim n_2$ times messages in a rotation cycle times and the message sizes are amongst $[l_1, l_2]$ (2) the preliminary energy of all nodes is varied.

Nodes communication associations are symmetric and nodes do not have any positional data, but they can estimate the distance amongst nodes rendering to signal forte expected. Nodes in the systems are prearranged in the method of groups. Cluster heads achieve the purpose of data fusion and are accountable for the subsequent information broadcast to the BS. There is only one BS in the systems and wireless transmission power is manageable.

Node initial energy is haphazardly dispersed in the closed interval [E_{min}, E_{max}], where E_{min} the lower bound of the energy is, E_{max} regulates the value of extreme node initial energy. For any node i, its initial energy is E_i.

3.1.3. Energy Model

Energy consumption model [10] to compute energy ingesting in communication, disregarding energy consumption of nodes in the process of computing, storage, etc. In the procedure of conveying l bits message over distance d, the energy ingesting of the transmitter is:

$$E_{Tx(l,\,d)} = E_{Tx\_elec}(k) + E_{Tx\_amp}(l,\,d) = \begin{cases} IE_{elec} + l\varepsilon_{fs}\, d^2, & d < d_o \\ IE_{elec} + l\varepsilon_{mo}\, d^4, & d \geq d_o \end{cases} \quad (1)$$

Receiver's energy consumption is

$$E_{Rx}(l) = E_{Rx\_elec}(l) = E_{elec} \quad (2)$$

Where $E_{elec} \rightarrow$ energy dissipated per bit to route the transmitter or the receiver, $l\varepsilon_{fs}\, d^2$ and $l\varepsilon_{mp}\, d^4 \rightarrow$ amplifier energy that rest on on the transmitter amplifier replica.

Basically, all WSN clustering procedures are projected to resolve the delinquent of unbalanced networks load, and to attain uniform distribution of energy intemperance at all nodes, so as to extend the network generation as much as probable. Consequently, EEPCA must take complete consideration of the following:

1. Algorithm should be completely distributive and self-organized. Nodes regulate their own state grounded only on local data, and every node must choose whether to turn out to be a cluster head or a member have its place to a group in the clustering phase;
2. Nodes with added residual energy must have greater possibility to turn into cluster head and it must be confirmed that the cluster has a lesser communication cost, but energy is not the only feature for cluster head selection;
3. Cluster load balancing must be confirmed;
4. EEPCA activates in rounds. To save energy ingesting when nodes transmission in preliminary clustering stage of every round, an energy forecast replica of RDA nodes is recognized.

3.1.4. EEPCA Clustering Algorithm

Computation of distance between nodes: Nodes in the systems can observe their mutual distance rendering to attenuation of signal forte in the procedure of transmission. In clustering stage, all nodes use definite transmission energy for transmission. For instance, with energy E_i^{tran}, node i transmissions data to other nodes, as well as its message sending cycle t_i, message length l_i and its energy data E_i. Node j notices the acknowledged signal strength (received energy). $E_{j,\,i}^{rec}$ while receiving messages. The association amongst transmission energy and reception energy is as trails.

$$E_{j,i}^{rec} = \frac{K}{d_{i,j}^{\alpha}} \times E_i^{tran} \tag{3}$$

Where K → constant, $d_{i,j}^{\alpha}$ → relative distance amongst node *i* and node *j*. α → distance-energy gradient in HWSN. Thus, the distance amongst *i* and *j* is:

$$d_{ij} = \sqrt[\alpha]{\frac{K \times E_i^{tran}}{E_{j,i}^{rec}}} \tag{4}$$

The node create a routing table of neighboring nodes grounded on received information and protect all pertinent data of all nodes within its communication choice. All nodes in the networks are noticeable by the only integer value, which is every node's ID. The data stowed in the routing table comprises the distance amongst the node and its neighboring nodes, cluster head node's ID, the distance to the cluster head, the current energy and predicted energy ingesting.

3.2. Cluster Head Selection

This anticipated research is established the enhanced LEACH-ERE procedure to enhance the energy of WSN grounded energy prediction examination. It is presented a novel donated procedure that protects energy by means of LEACH-ERE, with roughly other assistances. In this research an enhanced protocol had calculated and executed for WSNs that enhance energy indulgence, packet delivery ratio, end to end delay and lengthened lifetime [20].

1. It is cast-off to upsurges the energy saving and lifetime than prevailing energy effectual protocols.
2. It offers an improved CH selection system grounded on energy prediction method.
3. It is castoff to upsurge constancy epoch of the system which outcomes in decent output

The suggested LEACH-ERE etiquette is a heterogeneous clustering method, in which all wireless sensor nodes can choose whether to be a CH or not self-sufficiently. In LEACH all sensor nodes are qualified for CH selection procedure those have energy superior than zero, but in anticipated protocol predicted residual energy is measured which designate whether a node after execution as a CH can route a round positively or not. It progresses the stable area of the sensor network in which the whole nodes are alive.

Procedure

Input:

N: a network

a: a node of N

e: Energy

T: a threshold value to become a CH candidate chance (a): a suitability value of the node a to be a CH

k: the number of clusters

r: the number of times to be a CH

Output:

CH (a): the cluster head of the node a

isClusterHead (a): true if CH(a)=a

Function:

Broadcast (packet, distance)

Send (data, destination)

Receive (data, source)

LEACH-ERE ($E_{residual}$, $E_{expResidual}$)

Initialization:

$$E_{expConsumed}(l, d, n) = N_{packets} \times (E_{Tx}(l, d) + n \times R_{Rx}(l)) \quad (5)$$

$$E_{expResidual}(l, d, n) = E_{residual} - E_{expConsumed} \quad (6)$$

IsClusterHead (a) = false;

r←0

Main

For every clustering round

If $(r = \left[\frac{\text{size (N)}}{k}\right]$

IsClusterHead (a) ← false;

T ← 1;

Else T ← $\left[\frac{k}{\text{size (N)}}\right]$

End if

If (rand(0, 1) > T)

CH (a) ← a;

Apply equation (5) and (6) to improve the energy

Broadcast message

Receive message from CH

During the CH selection

if Sensor nodes energy level>= average energy level

then Sensor node suitable for cluster head

if Sensor node with highest energy (E) level work as a CH

else

Not eligible for cluster head selection process.

Calculate the distance of one node to all nodes.

for $i = 1$ to n do

for $j = 1$ to n do

d_{ij} = distance from s_i to s_j

End for

End for

Calculate the sum of all distance from one to all nodes.

for $i = 1$ to n do

for $j = 1$ to n do

$D_i = D_i + d_{ij}$

End for

End for

Select the CH which has minimum distance

And corresponding node will selected as CH

if (isClusterHead(a) = true)

broadcast(CH-Message)

receive and REQ message

else

receive CH message

send REQ message to the closest CH

end if

In each clustering round every sensor node produces a random number amongst 0 and 1. If the random number for a specific node is superior than a predefined threshold T, which is the percentage of the anticipated tentative CHs, the node becomes a CH. Then, the node computes the energy level and smallest distance to upsurge the CH competence. For k amount of cluster round r, efficient node first-rate as CH in WSN.

3.3. Super Cluster Head (SCH) Selection

PSO is an evolutionary algorithm which is used to optimize the parameters such as network life time, energy level, throughput, delay, minimum distance and packet delivery ratio. PSO as the furthermost prevalent optimization procedures which is grounded on Swarm Intelligence cast-off for fuzzy rule bases. The PSO fit in to the class of direct search approaches cast-off to discover an optimal way out to an objective function (fitness function) in a search space. A communication edifice is also distinct, conveying neighbors for every discrete node to interrelate with. Then a residents of individual node distinct as random deductions at the tricky solutions is modified. These entities are candidate way out. They are also recognized as the particles (sensor nodes), henceforth the name particle swarm. An iterative procedure to progress these candidate solutions is set in motion. The nodes iteratively assess the suitability of the candidate solutions and recollect the location where they had their best achievement. The individual's best way out is named the particle best or the local best. Every particle sorts this data obtainable to their neighbor nodes. They are also capable to see where their neighbor nodes have had achievement. Actions through the search space are directed by these successes, with the population typically converging (by the end of a trial) to a solution, which is improved than that of nonswarm method by means of the similar approaches.

The swarm is usually demonstrated by particles (nodes) in multidimensional space that have a position and a velocity. These particles fly through hyperspace (i.e. Rn) and have two indispensable cognitive competences: their distance of their own finest position and energy of the global or their neighborhood's best. In a minimization optimization difficulty, problems are expressed so that "best" merely incomes the location with the minimum objective value. Members of a swarm communicate decent locations to each other and regulate their own location

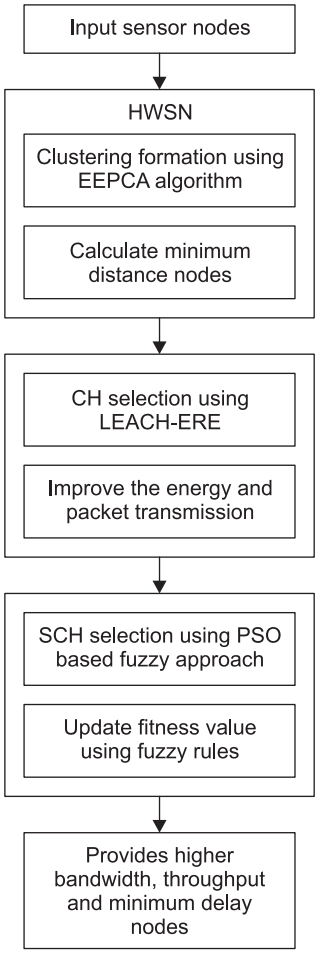

Figure 3: Overall block diagram of proposed system

and velocity grounded on these respectable positions. So a node has the subsequent data to sort a appropriate alteration in its position and velocity:

1. A global best that is recognized to all and directly rationalized when a novel best position is originate by any node in the swarm.
2. Neighborhood best that the node attains by collaborating with a subset of the swarm.
3. The local best, which is the finest solution that the node has seen.

The node position and velocity bring up to date equations in the humblest method that manage the PSO are specified by

$$v_{ij} \leftarrow c_o v_i + c_1 r_1(\text{globalbest}_j - x_{ij}) + c_2 r_2(\text{localbestij} - x_{ij}) + c_3 r_3(\text{neighborhoddbest}_j - x_{ij}) \quad (7)$$

$$x_{ij} \leftarrow x_{ij} + v_{ij} \quad (8)$$

As the swarm repeats, the fitness of the global best solution progresses (finds the minimum distance). It could occur that all nodes being prejudiced by the global best ultimately method the global best, and from there on the fitness not ever recovers in spite of numerous runs the PSO is repeated subsequently. The nodes also transfer about in the search space in nearby nearness to the global best and not reconnoitering the respite of search space. This spectacle is called convergence. If the inertial coefficient of the velocity is minor, all nodes

and the assortment of coefficients in the velocity-updating reckonings disturbs the junction and the aptitude of the swarm to discover the finest. One means to originate out of the condition is to reinitialize the nodes locations at intervals when convergence is noticed. To designate the SCH this investigation implants the fuzzy method with PSO algorithm.

In current years, certain methods have been offered to produce fuzzy rules and membership functions. A well-organized PSO grounded method to build a fuzzy rules base from specified WSN. This technique consider that the fuzzy logics can be also expressed as a space difficulty, where for each point of fuzzy sets corresponds to a fuzzy logic i.e. signify membership functions, rule base and henceforth the consistent system behavior [21]. The SCH is grounded on trails

$$E_{Tx} = E_{elec} \times k + \varepsilon_{amp} \times k \times d^2 \tag{9}$$

$$E_{Rx} = E_{Rx\text{-}elec} \times k \tag{10}$$

Here 'k' → message length and 'd' → transmission distance. Thus energy indulgence diverges linearly with message length and as a square for transmission distance. The SCH will be a node from selected cluster heads which will be at an optimum distance, system lifetime, least delay, high packet delivery ratio, greater bandwidth and energy deliberation from the base station. Thus by super-clustering[22] we may be cumulative the length of the ultimate conveyed message but by means of only one node for communicating to the base station a ration of energy is protected, since distance factor is abridged. The limitations are designed grounded on the weight basis and D signifies the distance, E represents the energy, P symbolizes the packets and NL means the network lifetime.

$$T_c = W_1 \times D + W_2 \times E + W_3 \times P + W_4 \times NL \tag{11}$$

Prepare every node weight = 0 is

Head = false p

Particles (nodes) = 0

Velocity = empty // To supply al., neighbor nodes Rendering to instantaneous topology,

Find neighbor // nodes in Range

If distance < Range

Edge exists

Else

No edge exists

Increment weight // connectivity measure

Compute objective function using (11) which performs minimum delay node, maximum packet transmission ratio, minimum energy and high network lifetime nodes

Find high transmission nodes with shortest distance using (9)

Set α, β, γ, δ values // control parameters

Iterate i to n times

Select i^{th} node as Super Cluster Head

First-rate neighbor with supreme possibility as subsequent cluster head till all nodes are protected

Evaluate fitness value

The fuzzy rules are produces effective membership functions

The fuzzy parameters act as particle (node)

The fuzzy parameters are optimized using (7)

The procedure is recurrent till aim is attained or optimization technique touched the global best

Update best node as SCH

Discover ultimate set of SCH with supreme possibility (with Weight and Updated nodes)

Get the optimal fuzzy set nodes as SCH

The algorithm describes that the optimal SCH is performed by using PSO based fuzzy approach and also the fuzzy rules are optimized using PSO optimally. It is used to reduce the number of iterations efficiently and improves the network lifetime significantly. A complete novel membership function effectively attuned from normal fuzzy membership function. It could be prepared with exemplification of fuzzy membership function value as particles (nodes). In the every repetition in optimization way, the node characterize will be vagaries to grasp the optimal value[23]. The membership function will shrivels, transfer or enlarge over the vicissitudes of every value. The Fuzzy PSO has attuned fuzzy membership function and enhanced the recital outcome in term precisely to target and quicker in rapidity of convergence.

4. EXPERIMENTAL RESULT

In this trial, the setup deliberated 40 nodes randomly positioned over the area amongst ($x = 0, y = 0$) and ($x = 100$, $y = 100$) with BS location ($x = 50$, $y = 50$). We take up four No. of clusters. Every round period is 20s. The bandwidth of the channel is 1 Mbps. Every data message is 500 bytes long; packet header length is 25 bytes. We have cast-off a simple energy prototypical. The communication factors and the essential factors of interest are specified in Table 1.

Table 1

Parameter	*Values*
No. of Nodes	100
Network Size	100 × 100 m
Mac	802.11
Radio Range	250 m
Simulation Time	2000 sec
Traffic Source	CBR
Packet Size	500 bytes

4.1. Performance Metrics

The subsequent metrics are used in the simulation to validate the recital of the proposed approach.

Control overhead: The whole amount of received data packets normalizes the entire amount of routing control packets is known as control overhead.

End-to-end delay: The average time taken by a packet to transmit from source to destination across the network is well-known as End to End delay.

Throughput: The ratio in which the data packets are successfully transmitted over the network or communication links is defined as throughput. It is sedate in bits per second (bit/s or bps). It is also specified by units of information processed over a given time slot.

Data Availability Ratio: It is specified as making data copies that can be shared by multiple users at a particular point of time.

4.2. End to End Delay

Figure 4 depicts that the comparison of end to end delay recital for existing LEACH, LEACH with fuzzy approach and proposed LEACH-ERE with PSO_Fuzzy methods. The nodes are varying from 20 to 100 and end to end delay is plotted for such nodes in nano seconds (ns). In x axis, the numeral of nodes are taken and in y axis end to end delay is occupied. The experimental result shown that the proposed LEACH-ERE with PSO_Fuzzy method provides lower end to end delay when compared with existing LEACH and LEACH with fuzzy approaches.

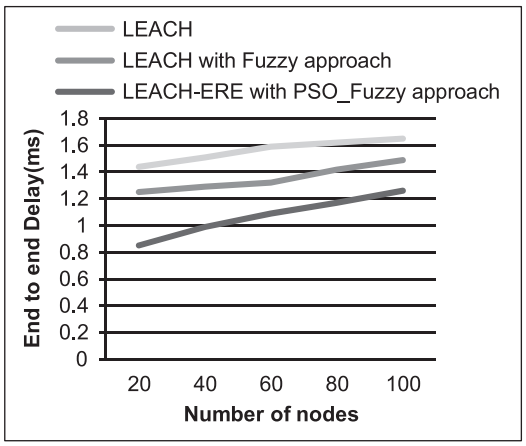

Figure 4: Number of nodes Vs End to End Delay

4.3. Bandwidth

Figure 5 illustrates that the comparison of bandwidth for existing and proposed methodologies. The existing LEACH, LEACH with fuzzy approach provides lower bandwidth values and the proposed LEACH-ERE with PSO_Fuzzy approach provides higher bandwidth values. The simulation proves that the proposed LEACH-ERE with PSO_Fuzzy approach has higher performance for numeral amount of nodes in the specified system.

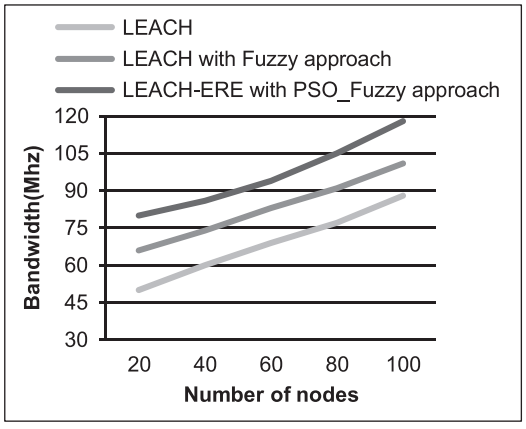

Figure 5: Number of nodes Vs Bandwidth

4.4. Throughput

Figure 6 shows the comparison result of existing LEACH, LEACH with fuzzy approaches and proposed LEACH-ERE with PSO_Fuzzy approach in terms of throughput. For x axis, the number of nodes are plotted and for y axis throughput is plotted. The nodes are varying from 20 to 100 nodes for existing and proposed system. The proposed method concludes that the higher throughput is shown by using LEACH-ERE with PSO_Fuzzy approach compare than existing LEACH, LEACH with fuzzy approaches.

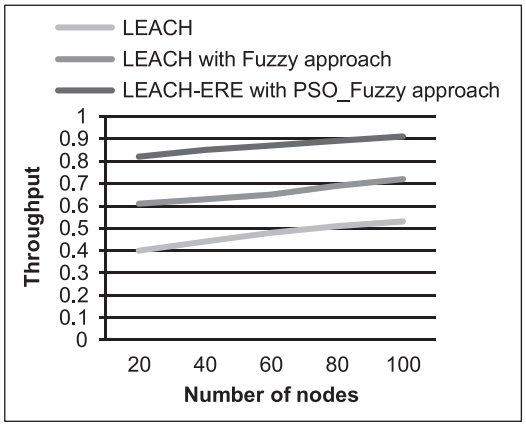

Figure 6: Number of nodes Vs Throughput

4.5. Packet Delivery Ratio

Figure 7 illustrates that the comparison of packet delivery ratio for existing and proposed methodologies. It is measured by amount of packets acknowledged divided by number of packets actually sent. The simulation proves that the proposed LEACH-ERE with PSO_Fuzzy approach provides higher packet delivery ration rather than the existing LEACH, LEACH with fuzzy approaches.

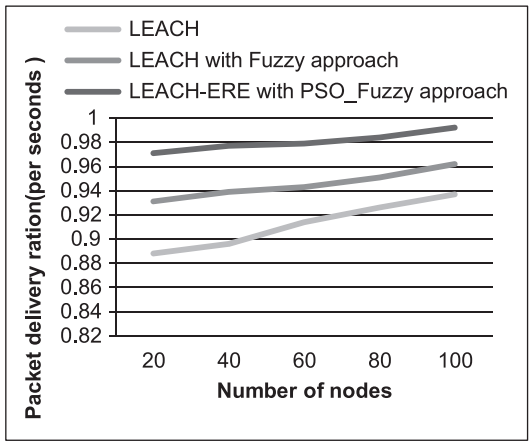

Figure 7: Number of nodes Vs Packet Delivery Ratio

4.6. Energy Consumption

Figure 8 illustrates that the comparison of existing LEACH, LEACH with fuzzy approaches and proposed LEACH-ERE with PSO_Fuzzy approach by means of total energy consumption. The sensor nodes are varying from 20 to 100 nodes. In x axis amount of nodes is plotted and in y axis energy consumption is plotted. The

proposed scheme is shown the lower energy consumption using LEACH-ERE with PSO_Fuzzy approach rather than existing LEACH, LEACH with fuzzy approaches.

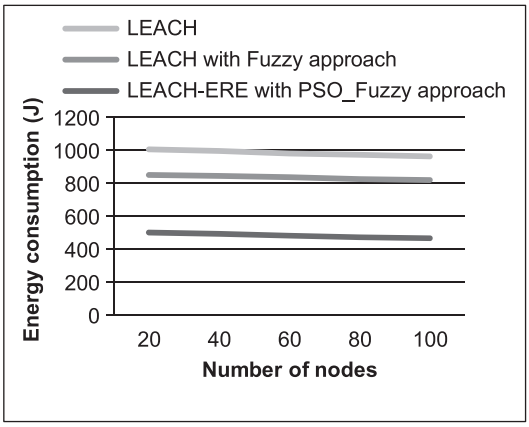

Figure 8: Number of nodes Vs Energy consumption

4.7. Network Lifetime

From the Figure 9, the graph provides network lifetime for the given network size. It illustrates that the proposed LEACH-ERE with PSO_Fuzzy approach has higher network lifetime compare than existing LEACH, LEACH with fuzzy approaches.

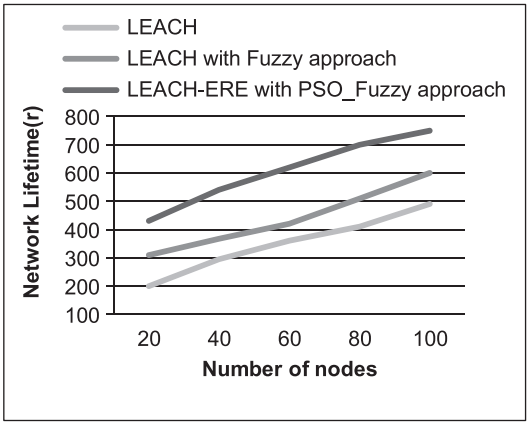

Figure 9: Number of nodes Vs Network lifetime

5. CONCLUSION AND FUTURE WORK

In this research, HWSN is anticipated EEPCA for efficient communication along with better network performance. The existing system has issue with clustering formation and cluster head selection. To avoid these problems, the proposed research introduced EEPCA for handling clustering formation in HWSN, LEACH-ERE protocol for CH selection and PSO based fuzzy approach for SCH. Thus the proposed research has three modules and they are: (1) Clustering formation using EEPCA in HWSN, (2) CH selection by using LEACH-ERE, (3) SCH using PSO based fuzzy approach. EEPCA approach is to protect energy ingestion when nodes transmission in primary clustering stage of every round, an energy forecast replica of nodes is recognized. Then, CH is selected by using LEACH-ERE protocol which selects the nodes highest energy level of sensor nodes and bandwidth. It has efficiency for transmitting rapidly the required information in the given network. Then apply the PSO

algorithm for selecting the SCH along with fuzzy rules. This approach is very useful to choose the superior nodes among several nodes. It has capability to manage scalable HWSN which leads network performance higher. Thus the proposed LEACH-ERE with PSO_Fuzzy approach provides higher packet delivery ratio, bandwidth, network lifetime, throughput and lower in energy consumption and delay. Hence this research concludes that the proposed LEACH-ERE with PSO_Fuzzy approach has robust network performance compare than previous LEACH and LEACH based fuzzy approach. Still this research has issue with attack detection and hence it can be extend to be future work.

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