Advances in Wireless and Mobile Communications.
ISSN 0973-6972 Volume 10, Number 1 (2017), pp. 89-109

http://www.ripublication.com

ACCGP: Enhanced Ant Colony Optimization, Clustering and Compressive Sensing Based Energy Efficient Protocol

Supreet Kaur[1] and Rajiv Mahajan[2]

[1]Research scholar, [2]Principal
[1]Department of Computer Science and Engineering
[1]Punjab Technical University, Punjab, India.
[2]Golden group of institutes, Punjab, India.

Abstract

With rapid advancements in wireless communications, energy efficiency has recently turned out to be the primary issue in wireless sensor networks. Since sensor networks can be powered by small as well as limited batteries, thus they become dead after a period. Therefore energy conservation and balancing of energy dissipation become more challenging problem to improve the lifetime of sensor devices. The hybridization of clustering and tree based aggregation for sensor networks have been found to be a proficient way to enhance the network lifetime. Captivating motivation from nature-inspired optimization; this research work proposes an ACCGP protocol which utilizes clustering, Ant Colony Optimization (ACO) based routing and compressive sensing for wireless sensor networks. ACCGP protocol decomposes the sensor network into numerous segments hence called clusters, and cluster heads are chosen in every cluster. Then, ACO based data aggregation come in action and collects sensing information directly from cluster heads by utilizing short distance communications. The compressive sensing reduces the amount of data which is going to be transferred in the sensor network. The simulation analysis shows that the ACCGP protocol considerably enhances network lifetime by conserving the energy in the more efficient manner than other protocols at present deployed for sensor networks.

Index Terms: Wireless Sensor Networks, Ant Colony Optimization, GSTEB, Energy Efficient.

1. INTRODUCTION

Wireless sensor networks (WSNs) are the collection of an improved amount of low-priced and little warning nodes. The system is intended for data congregation from the atmosphere as well as linking together via wireless signals.[3] Various programs of WSNs contain house knowledge, traffic and environment monitoring [1]-[3], etc.[3] It is also used for monitoring ecological or physical houses around the sizable region, such as heat, stress, luminosity and vibration [18].Sensor nodes are trusted for gathering data in several programs for example monitoring [8], monitoring of essential services [9], Car tracking[5], volcano monitoring [13], monitoring animal habitats [3] and permafrost monitoring [17]. In WSNs, the warning nodes in many cases are structured in enormous amounts and are often battery-powered, so it is impossible to charge or change them with tens and thousands of physically embedded nodes in the network. Hence, nodes of power conserving, to be able to improve the time of the system is one of the extreme situation in the WSNs study region [3]-[7].

Knowledge communication among the warning nodes in the WSN is one of the principal purposes of power consumption. Therefore an energy efficient practice is supposed to employ. To attain the aim, we need not only to decrease the full total energy use but also to steady force in the system [23]. The most thoroughly used power keeping strategy is the info aggregation. Knowledge gathering at the sink by the average person nodes effects into flooding of the info that in turn causes the maximum power use thus degrading the system lifetime. In this paper, we propose an improved method for General Self-Organized Tree based Energy Balance routing protocol (GSTEB). In present GSTEB protocol routing tree is manufactured where tree centered routing is performed to transmit knowledge to the bottom section however in that if the parent node dies the topography must be repaired again that'll consume a lot of power, and there might be the loss of knowledge also. To prevail around the problem of sign delay and experience reduction in the system because of the nodes disappointment in the root to sink, cluster based aggregation process can be utilized. In a big system, well- organized sign of knowledge to the sink requires obtaining the maximum route according to how many trips; therefore knowledge can be aggregated at group head which is to be transmitted to the bottom station. The clustering strategy may minimize knowledge redundancy and reduce the congestive routing traffic in knowledge transmission. Following the clustering tree centered routing at the cluster-heads, it is required to obtain the shortest path between the source and the sink, but the smallest route issue is NP-Hard in nature

The acceptable redirecting is needed for increasing the lifespan of little power and well-compacted nodes of the sensor. So artificial intelligence could be used on the cluster-heads for active redirecting via standardized Ant Colony Optimization centered pine construction to obtain the greatest trusted functioning period. ACO will deliver lengthier lifetime and increased scalability [5]. The efficiency of GSTEB could be improved further by applying compression on the cluster- heads. This will lead to more energy usage and compress data before the sign is a successful technique to energy preserving of the nodes. One research has unveiled that the vitality use for performing 3000 recommendations is carefully added up to the power consumption for sending one touch over a range of 100 m by radio [2]. Ergo, compressing data previously sending it to the beds base station is an adept way to make great utilization of nodes limited battery power, thereby conserving the energy. [3].

Based on the dependence on fully retrieving the compressed precise data Lempel-Ziv-Welch (LZW) algorithm will undoubtedly be used. Integration of Clustering, Compression and ACO with pine-centered redirecting is proposed to significantly lower the vitality usage so that there may be an escalation in the balance period, network lifetime and scalability related to data collection in instant warning system. Another progressive direction-finding technique using high power effectiveness i.e. EESSC is projected that depends upon the enhanced hierarchical grouping method. In EESSC, the remaining power of all detector vertices will be considered in grouping process. Along with this, parcel leader is selected who will give a complete report regarding remaining power of vertices. At the point when the groups have been shaped, vertices in a group will be exhibited in the register. After that group in charge will interchange consequently according to the sequence. Than a re-group method is intended to actively modify the outcome of grouping to create sensor vertices sensible [29].

A new power alert various leveled group based direction finding routing procedure is projected using two objectives: reduce the aggregate power utilization and guaranteeing justice of power utilization among vertices. The transfer vertex is demonstrated by selecting query as discontinued encoding trouble and by utilizing the technique of curved use the property of convex capacity to locate the ideal arrangement [30].

A new active round -base directing plan for relationship information gathering named Ring-Based Correlation Data Routing program is projected.Now to begin with this nodal scheme information is forwarded to rings that are having the huge amount of power in the least bounces. After that complete information is sent to the sink by using straight path. In this case, information is gathered in non-hotspots areas, i.e., areas containing full power and sends all the gathered information to sink, accomplishing little information transmitted to the base station. It helps in reducing power utilization in hotspots and thus decreasing the energy consumption in hotspots close to the base station. In this way, it enhances the system lifespan [31].

The rest of the report has systematized as follow: Part 2 mentioned the related work. Part 3 represents the proposed algorithm, and part 4 explains the analysis of results. Finally, Part 5 ends the report and shows the conclusions.

2. RELATED WORK

GSTEB [15] is a technique in which redirecting tree is created in each round. Bottom section selects one origin node among all of the alarm nodes and broadcasts collection of the root node to all alarm sensors in the network. Consequently, every sensor chooses its parent by contemplating itself as well as with their neighbor's information. A simulation outcome reveals that GSTEB offers an improved performance then various protocols in the management of energy use and also prolonging the device duration.

In Low-Energy Adaptive Clustering Hierarchy (LEACH)[12].Leach operation is divided into two degrees set-up period and continuous period.In the arrangement, each and every node chooses whether to turn into CH or not. Subsequent the selection of CHs, various nodes may join their nearest CH and may join their cluster. Every node selects the nearest CH. In the steady-state period, CHs may mix the acquired knowledge from the class people as well as produce the merged knowledge to BS.

Hybrid, energy-efficient, distributed clustering algorithm (HEED) [9] is step-up within the LEACH along the way of a collection of the group heads. That protocol prefers the CH in line with the extra power of every node. HEED protocol assures that here exists only one CH in just an accurate selection of the system. Therefore there's all the time a standard distribution of the group minds in the system thus ensuring minimal power usage by improving the system lifetime.

Power Efficient Data Gathering and Aggregation in Wireless Sensor Networks (PEDAP) [4] represents a tree-based redirecting project where all of the alarm nodes in the system variety a minimum spanning Pine thus resulting in minimum energy usage for knowledge transmission. Another variation of PEDAP is known as PEDAP-PA which somewhat raises the power usage for knowledge indication but balances energy usage per node.

Tree-Based Clustering (TBC) [19] can also be a growth above LEACH protocol. The chaos development in TBC is same while the LEACH protocol. In TBC, nodes in just a chaos build a redirecting pine where cluster-head is the leading of the tree. A number of levels as well as level of the pine is by the range of the associated sensors to their chaos head.TBC project is equally the GSTEB as in TBC also redirecting pine is build and also each node documents the data of most its neighboring nodes and appropriately forms the topography.

Lempel-Ziv-Welch (LZW) Algorithm is a general lossless knowledge pressure algorithm [14, 15]. It is a lossless dictionary lookup-based pressure algorithm [12]. The principle working of LZW algorithm is comparable to the dictionary. This algorithm squeezes material identity by identity, these characters are afterward joined to create a string that will be referred to a particular signal, and these strings are included with the dictionary. Therefore LZW algorithm generates a string dining table during coding that documents all the type strings those have formerly seemed and there is no replication. After that each time a string is similar it could be referred to that code. The LZW decompression algorithm may replicate the dictionary at the same time frame as running the squeezed knowledge; therefore it does not need to transmit the dictionary. This pressure algorithm is lossless, easy, consultant, the rapid rate with little difficulty and found in a diversity of purposes such as lossless picture pressure [17] and text pressure [16].

Ant colony optimization (ACO) is certainly an algorithm based on the natural behavior of the actual bugs. Its primary motive is to acquire the fastest journey starting from the resource to the food. It employs the effectiveness of the real bugs during a search for the food. It has been observed that the insects deposit an amount of pheromone above the trail during touring from the nest to the meals and vice versa. With this method, the little journey of bugs is estimated so that they may reach the destination before the drying of pheromones. ACO method can be utilized in the machine redirecting troubles to acquire the fastest route. With this method of redirecting position, many synthetic bugs are simulated from the resource to the drain i.e. destination. The forward bugs can build one more node randomly for the first time receiving the info from the redirecting dining table, and the bugs that are sufficient to attain the place may upgrade the pheromone deposit at the last visit. Ant colony optimization escalates the scalability as well as alarm functioning period.ACO employs the substantial flexibility and optimization ease of the ant colony to acquire the maximum method relating to the signal nodes.

3. PROPOSED ALGORITHM

<u>Algorithm of Ant Colony Optimization based Hybrid Tree Based Routing Protocol(AHTRP)</u>

/*Initialization of WSN*/

1. $Deploy\ sensor\ nodes\ randomly$

   // Each node i will be placed randomly in predefined sensor field with its initial energy.

2. $Apply\ T(n)\ threshold\ function\ to\ elect\ Cluster\ Heads(CHs)$

$$T(n) = \begin{cases} \frac{P}{1-P*\left(r \bmod \frac{1}{P}\right)} & if\ n \in G \\ 0 & otherwise \end{cases}$$ *// Where P is the required percentage of the cluster- heads, r represents the current round and G represents the set of nodes that has not been the cluster-head in the last 1/P rounds.*

3. $Every\ node\ choose\ a\ random\ number\ R(n) between$ 0 & 1.
   $if\ R(n) < T(n)\ then$
   $the\ node\ 'n'\ becomes\ the\ CH\ for\ the\ current\ round$
   $else$
   $node\ 'n'\ becomes\ the\ CMs(cluster\ members)$
   end

4. $Elected\ CH\ broadcast\ the\ advertisement\ message\ to\ sensor\ nodes.$

5. $Association\ will\ be\ done\ by\ evaluating\ the\ distance\ between\ each\ node\ with$ $Euclidian\ distance\ and\ each\ member\ node\ will\ be\ associated\ with\ that\ one\ which\ is$ $than\ others$
   $$d = \sqrt{(W(i).xd - W(CH).(xd)^2) + (W(i).yd - W(CH).(yd)^2)}$$
   // W (i).xd and W (i).yd represents the sensor nodes along x-axis and y-axis

6. $CH\ allocate\ TDMA\ schedule\ to\ CMs.$

7. $Associated\ member\ nodes\ will\ send\ data\ to\ their\ CHs\ as\ per\ TDMA\ schedule.$ $act\ as\ a\ root.$

8. $Apply\ LZW\ Compression\ on\ each\ CHs$
   $CPS = APS \times CR$ *// CPS is Compressed packets size, APS is actual packet size and CR is the Compression ratio*

9. $Find\ distance\ between\ CHs\ using\ Euclidean\ distance$:
   $$distance = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

10. $Apply\ Ant\ Colony\ Optimization\ to\ find\ the\ shortest\ path\ to\ send\ data\ from$ $station(BS)\ by\ using\ ACO\_WSN.$

11. $Call\ \ Pt = ACO\_WSN(CHs, distance\ between\ CHs, BS)$

12. $Based\ upon\ the\ elected\ path\ \ Pt\ \ \ the\ communication\ will\ be\ done\ between\ BS$

13. $Evaluate\ and\ update\ energy\ consumption$
    i. $W(i).E = W(i).E - ((Tx_{energy} + EDA) * (K) + efs * K * (d^2\ )): if d < d_o$
    ii. $W(i).E = W(i).E - ((Tx_{energy} + EDA) * (K) + amp * K * (d^4)) : if d > d_o$

// *W(i).E is the energy of i*[th] *node, EDA is effective data aggregation,* Tx_{energy} *is the Transmitter energy,* K *is the packet size,* efs *represents the free space and amp is the multipath,* d_o*is the minimum allowed distance.*

14. $Check\ the\ dead\ node$
    $if\ W(i).E < 0$ *//W(i).E is the energy of the* i^{th} *node*
    $dead = dead\ +\ 1$
    end

15. $Stopping\ criteria$
    $If\ all\ the\ nodes\ are\ dead\ then$
    $display\ network\ lifetime$
    $else$
    $move\ to\ step$ 2
    end

16. $Return\ network\ lifetime$

Sub algorithm
ACO_WSN ($CHs, distance\ between\ CHs, BS$)

1. Initialize CHs as ants combined with base station(BS) as Destination.
2. Going of virtual ant depends on the amount of pheromone on the CHs distances
3. The first step in ACO could be the trail collection between neighboring clusters ,some synthetic ants (CHs) are simulated from the CHs to the bs.
4. The ahead ants are choosing the following CH randomly for initially taking the data from the length matrix and the ants who are successful in achieving the BS are updating the
   pheromone deposit at the edges visited by them by an amount (CL),where M is the sum total journey period of the ant and D a constant price that is adjusted in line with the fresh
   problems to the perfect value.

5. The following set of the ants can now study on the pheromone deposit feedback left by the
formerly visited successful ants and will soon be guided to follow along with the quickest path.
1. When someone ant walks from CHi to CHj,the chance in the selection principle for a simple ant is:

$$P_{i,j} = \frac{(\tau_{i,j})^{\alpha} + (\eta_{i,j})^{\beta}}{\Sigma(\tau_{i,j})^{\alpha}(\eta_{i,j})^{\beta}}$$

// where $\tau_{i,j}$ represents the amount of pheromone deposit from CHi to CHj; $\eta_{i,j}$ is the trail visibility function that is equivalent to the reciprocal of the energy distance between CHi and CHj; α is the parameter to adjust the amount of pheromone $\tau_{i,j}$.;β is a parameter to adjust the heuristic visibility function $\eta_{i,j}$.

1. $if\ the\ link\ between\ two\ CHs\ exists, then$
   $P_{i,j}\ will\ be\ updated$
   $else$
   $Pij = 0.$
   end

2. $Evaluate\ the\ distance\ between\ the\ cluster\ head\ i\ and\ cluster\ head\ j$
   $\eta_{i.j} = \frac{1}{E_{DIS(i,j)}}$
   $E_{DIS}(i,j) = (E_{TR\_ELE} + E_{AMP}) \times S = (E_{TR\_ELE} + \gamma \times \| d_{i,j} \| 2^{\lambda}) \times S$

//where $E_{DIS}(i,j)$ represents Energy distance metric between two Cluster heads i and ||.||2 represents the Euclidean distance; $E_{TR_{-ELE}}$ is the overhead energy of transmitter electronics and E_{AMP} is the transmission energy and γ is a coefficient of amplifyi and S is the pack size.

3. $P\ values\ will\ be\ updated\ by\ all\ the\ ants\ which\ have\ reached\ the\ BS\ successfu$

4. $Pheromone\ evaporation\ (\rho) on\ the\ edge\ betweenCHi\ and\ CHj\ is\ implemented$

   $\tau_{ij} \leftarrow (1-\rho)\tau_{ij}$, *// before adding the P, the evaporation action has to be performed. The evaporation helps to find the shortest path and provide that no other path will be assessed as the shortest. This evaporation of pheromones has an intensity ρ.*
5. $CHs\ not\ chosen\ by\ artificial\ ants, the\ amount\ of\ P\ decreases\ exponentially.$
6. $Every\ moment\ of\ time, t = \{1,2,3,4 \ldots n\}. All\ the\ ants\ will, after\ n\ iterations\ find\ the\ solution$

and leave the P calculated by the following formula:

$\tau_{ij}(t+n) = \rho.\tau_{ij}(t) + \Delta\tau_{ij}$ // *Where* $\Delta\tau_{ij}$*is the amount of pheromone being deposited.*

7. *If ant k has passed some edge between the CHs, it will leave P which is inver to with the total length of all the edges ant k has passed from the starting CH t using formula*:

$\tau_{ij} \leftarrow \tau_{ij} + \sum_{K=1}^{m} \Delta\tau_{ij}^{K}, \ \forall(i,j) \in L.$ // $\Delta\tau ij^{k}$ *is the amount of P ant k deposits on the edges visited. It is calculated by the following expression:*

$\Delta\tau_{ij}^{K} = \begin{cases} 1/C^{K} \\ 0 \end{cases}$ //*Where* C^{K}*is the total length of all the edges*

8. *Now the path with best P value (minimum distance) is selected to communic CHs and BS.*

End

4. SYSTEM MODEL

The movable spontaneous network can be symbolized by undirected network in which edges connecting to the pair of vertices may converse in a straight line. This network is displayed as Ḡ(N,L,LW), where “N” represents set of all vertices and “ L” represents set of edges between vertices. There are “X” number of vertices in a network. The utmost range of N_x to converse depends upon the radius Ʀ .An edge (p, q) denoted by L (p, q) € L, occurs between N_p and N_j can easily converse with one another. LW represents weight of directed edge (p, q) which is dependent on pheromone upgrade ruling. So, the Set_N is considered to be dynamic in natural life.

Consider X_{r1} hop as the instant neighbor of a vertex p in the maximum communication range and vertex q as instant neighbor of vertex p; than there exists a direct link in node p and node q.

4.1 RSSI based distance determination

Received Signal strength Indicator helps to find out the exact information related to vertices and according to this information, the necessary communication power may be given to that vertices. When the data is exchanged, than the power of acknowledged signals helps us to find out that how far the vertices (p,q) are from each other. Formula that shows the link between RSSI and probable distance is,

$$\mathrm{RSSI_{p,q}} = -(\mathrm{P_W} + 10_\mathrm{n} \log\left(\frac{\mathrm{D_{p,q}}}{\mathrm{D_0}}\right) \mathrm{d_s}\, \mathrm{B_m} \quad \ldots\ldots\ldots\ldots\ldots\ldots.. \quad 1$$

If D_0 =1m, than

$$D_{p,q} =_{10} ((P_W - RSSI_{p,q} / 10_n)/m \quad \text{-------------------} \quad 2$$

As distance from source increases, the speed of signals degrades and this path loss gradient is represented by l. The parameter P_W and l can be assumed by combining 0.5 P_W.

Value of n is 2-4.

$$P_W = P_L - 10 \log_{10} E \quad \text{---------------------3}$$

Distance of P_L is 1m in dB

E is Transmission Power.

In order to simplify, pathway defeat model, tentative arrangement of Mobile Ad Hoc Network having X number of vertices can be implemented using IEEE802.15.4 Physical layer and Media Access Control layer, along with data rate of 1Mbps, a 92dBm recipient compatibility. Rate of recurrence of a carrier is 2.4 GH_Z for interior OLOS [24] set-up and grade for path loss is n=3.3. So, the acknowledged communication range is,

$$Pr = EF(\left(\frac{D_{p,q}}{D_0}\right)^n = EF_{10}[^{0.1}(P_W - ^{RSSI}(_{p,q}))] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots4$$

$$\text{i.e } F = T_a T_b((\lambda - /4\pi)2$$

is open space expand. The handset radio wire pick up $T_a = T_b = 1.5$ and communicate range is 1mW (i.e0dBm). The bend of RSSI(dBm) along with definite expanse in m compose that vertices which are very near to each other has high RSSI and thus the power used in arriving at the nearby vertex can be decreased. Primary power of movable vertices is 200j with extreme working power of 3.4V and least working power of 2.6V. So, the least power that is must for a vertex to be active in the system is 120j. The edge ∃ is rate estimation of vertices primary power and thus the edge vitality is measured as 140j.

4.2 ATP Calculation

The main goal of ATP is to utilize the energy in a a very efficient way by amending the use of energy vertex. It may help in increasing the lifetime of all vertices as well as lifetime of the network. Energy of vertices is basically dependent upon the distance. So, an algorithm named ATP has been proposed in order to amend the energy of vertices until it listen to the certain neighboring vertices.

Let $E_{p,q}$ as the least energy that is must so that parcel may go from q to p; than

$$p, q€L \text{ if } E_{p,q} \le E_{pmax}$$

Thus $$E_{Adp\ Transit} = E_{p,q} \left(\frac{E_{pmax}}{E_{recieved}}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

So $$E_{p,q} < E_{Adp\ Transit} < E_{p}max$$

Percentage decrease in energy according to distance is

$$\%\ E_{saved} = \{ 1 - (\frac{E_{Adp\ Transit}}{E_{pmax}})\}100 \quad \ldots\ldots\ldots\ldots\ldots\ldots 6$$

At whatever point, a vertex starts a session, it turns into a source vertex shown as p and checks its $E_{(Adp\ Transit)}$ for its nearest vertex{s}. Now consider γ as total parcels to be sent. So energy required per session will be

$$\text{Energy required} = \gamma \frac{E_{Adp\ Transit}}{I_{p,q}} \quad \ldots\ldots\ldots\ldots\ldots 7$$

So, $I_{p,q}$ will be initial rate occurs in vertex p and vertex q and it is also the normal number of parcels overhauled every moment. Remaining power of 1 bound adjoining vertex will be

$$PR_{1hop} = E_{Adp\ Transit} \text{ x Parcel length/Bandwidth} \quad \ldots\ldots\ldots\ldots 8$$

Parcel length is the length or size of parcel.

4.3 Independent confinement based adequate active way using Ant Colony Optimization

Based on the planned procedure, ant colony optimization has been utilized in order to get active way from initial point to reach to the goal. ALEEP_with_ACO plans to locate the ideal way which can decrease the power utilization of the portable vertices and increments the life expectancy of the system. On one hand, it also controls the energy which is being utilized per bounce and finds the convenient way on the basis of remaining energy in order to improve the general execution of the system.

4.3.1. To collect site data by means of **received signal strength indicator**

Location dependant ant colony optimization is a combined technique in which a track is looked just as soon as an accumulation in information parcels which we have to forward to the goal vertex V_2 beginning at vertex V_1.When any vertex joins the system or starts moving, it immediately sends hello parcels to show its existence in the system. Now each vertex finds its separation with its prompt neighbors using RSSI values.

4.3.2 Independent confinement based adequate active way using Ant Colony Optimization

In this, planned calculation depicts the accompanying lane detection, probable lane choice along with lane protection stages.

4.3.3 Lane detection stage

In this a initial vertex V_1 desires to converse with the goal vertex $V_{2.}$ So ALEEP_with_ACO will help the both vertices by utilizing the location of vertex in order to search the path.

Step 1: Initial vertex V_1 will send a request parcel QRE to its 1 hop adjacent vertices from the list S. Directing Table (T) includes 1 hop adjacent vertices S {(ne1, g; ne2, g….nez, d)}. The request parcel QRE helps to find the goal of each vertex .Along with this it also checks if there is any existence of V_2 present in directing table.

Step 2: If there exists any entry of V_2 in T than PRE reply parcel is send to $V_{1.,}$ otherwise move to next point.

Step 3: Now , one bound adjacent vertices transfers QRE parcels to their adjacent vertices by updating probable way array field and move to step 2. Due to movable nature of MANET vertices, there may be a possibility that V_1 moves itself and selects itself adjacent to transitional vertices. In that situation transfer of QRE parcels to vertex V_1 is avoided.

Step 4: Finally QRE parcel will arrive at the goal vertexV_2.For every QRE got before the ending time (ERE), a PRE parcel is produced by V_2 forwarded to V_1 by backtracking the way through which that specific QRE is send.

4.3. Position and power alert potential path assortment stage

Independent confinement based adequate active way using Ant Colony Optimization utilizes the combined assessment ability in order to find way through capable dynamic vertices having more energy as compared to a recommended limit and with the base aggregate broadcast energy of vertices. The calculation utilizes ahead ANT (Forward Ant) advance method to keep the quantity of created ants as little as could be expected under the circumstances. In this pheromone act as an edge weight of the connection in the vertices. The initial vertex starts path foundation by sending forward ant to two conceivable ways from the group whose primary adjacent vertex is nearer to initial vertex recognized from the navigation table. Forward Ant parcel includes

AS	Req_P	γ	WE_{Cum}	AD

In this AS = Initial Point

Req_P = power needed to transmit γ parcels

WE_{Cum} = load of boundary

AD = Goal Point

Thus by accepting forward ants each of the following hub during the way affects residual vitality of hub as neighborhood heuristic constraint by contrasting it and the Eneeded. The choice to distinguish a qualified fiery hub depends on the pheromone overhaul administer given by

$$EL_{Nr_{1hopk}} - Req_P > E_{th} \text{ ,than } WE_{Cum_{y,z}} = 1 \qquad (9a)$$

$$EL_{Nr_{1hopk}} - Req_P = E_{th} \text{ ,than } WE_{Cum_{y,z}} = 0 \qquad (9b)$$

$$EL_{Nr_{1hopk}} - Req_P < E_{th} \text{ ,than } WE_{Cum_{y,z}} = -1 \qquad (9c)$$

Where Req_P got from Equation7, $EL_{Nr_{1hopk}}$is the remaining power of adjacent vertex and E_{th} is least power that forces a vertex to be alive in order to increase the existence of system. The middle vertex k figures out its combined boundary load WE_{Cumk} by getting WE_{Cum} from forward ants parcel got as,

$$WE_{Cumk} = WE_{Cum} + WE_{y,k} \qquad \ldots\ldots 10$$

Thus , the pheromone advance lead is reliant on the remaining power of vertex. Selecting a vertex with elevated remaining power, the more noteworthy would be WE_{Cum}, bringing about either increment or no adjustment in the current pheromone esteem. This idea of pheromone dissemination gives more data about accessibility of conceivable way enhancements in vertices and it may control forward ants.

Another Forward ant has been produced with WE_{Cumk} and sent to the subsequent vertex recorded in conceivable way cluster []. The assessment work computes the total load of the connections connected with the conceivable way and chooses a way with more load in view of the condition

$$WE_{Cum_{(i+1)}} > WE_{Cum(i)} \qquad \ldots\ldots 11$$

On effectively achieving the goal vertex, the forward ant changes to backward ant. Ant follows the way stored by forward ant .When the starting forward ant reaches at goal vertex; it introduces (EXP) Expiration Timer. When EXP terminates, then goal discards forward ants got later than EXP and begin preparing. Now forward ants will find out the suitable way utilizing estimation ability. Once the ideal way has been found, the goal saves every single conceivable way in next steering table as substitute way which can be utilized as a part of case the ideal way fizzles or is no more extended a substantial way.

5. COMPARISON AND SIMULATION RESULTS

The MATLAB simulation tool is used for simulation purpose. It evaluates the performance of the proposed technique with existing technique i.e. GSTEB on the following metrics i.e. stability period, network lifetime, residual energy (average remaining energy), and throughput by taking 100 sensor nodes. Other parameters for simulation are adapted from the GSTEB [15]. The sensors distributed arbitrarily in a 100×100 area with the base station at (50m, 150m). Simulation is run ten times and based upon the same box plots are developed. Since as known in prior, the box plot is the convenient method of dramatically representing the set of mathematical facts. It can easily depict straight lines expanded from the table that demonstrates unpredictability external from downward and upward quarters. Exceptions can be represented as the particular dot. It exhibits deviation as an instance of numerical inhabitants exclusive of creating some hypothesis of the first numerical circulation. The gap between different components of box demonstrates the level of scattering in the information, and explain exceptions. Along with this, it permits one to outwardly evaluate different L-evaluation, strikingly the range of values of frequency distribution, midhinge range, average in quantity, and weighted average of the distribution's median.

Stability period of a network is the time when the first node dies in the system. Figure 1 represents the comparison of the proposed technique with available one. The figure is clearly indicating that the stability period of the proposed method is significantly improved. Due to the random deployment of the sensor network there exist variation in stability time whenever simulation is run. But when compared to available protocols, it is found that the stability period of the proposed technique is consistent and maximized than available well-known protocols.

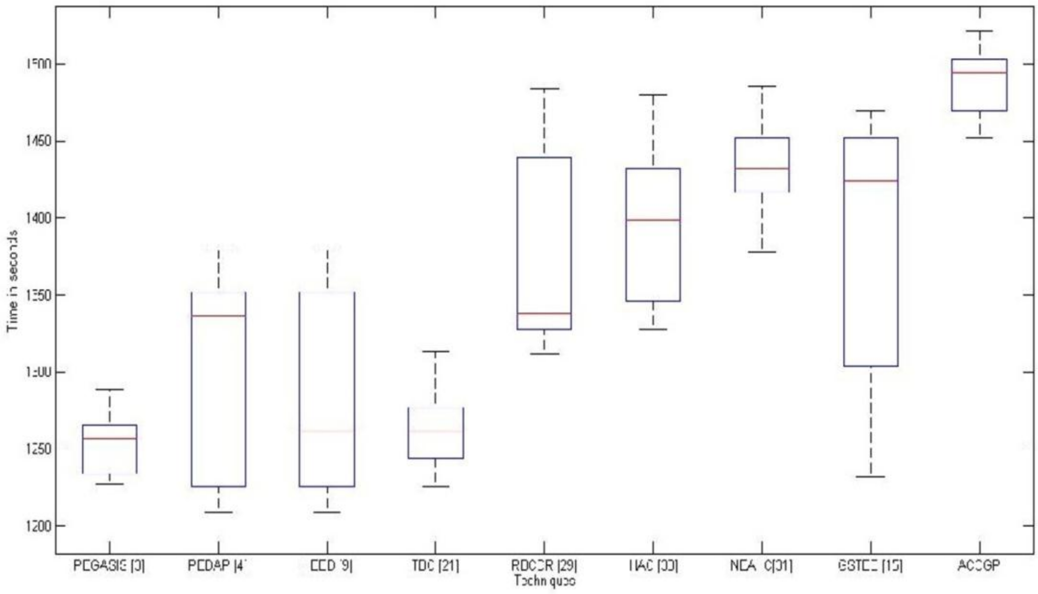

Figure 1. Comparison of Stability Period

Network lifetime of a network is the time when last ever node die in the network. Figure 2 represents the comparison of the proposed technique with available one. The figure is cleary indicating that the network lifetime of the proposed technique is significantly improved. Due to random deployment of the sensor network there exist variation in network lifetime whenever simuation is run. But when compared to available protocols, it is found that the network lifetime of the proposed technique is consistent and maximized than available well-known protocols.

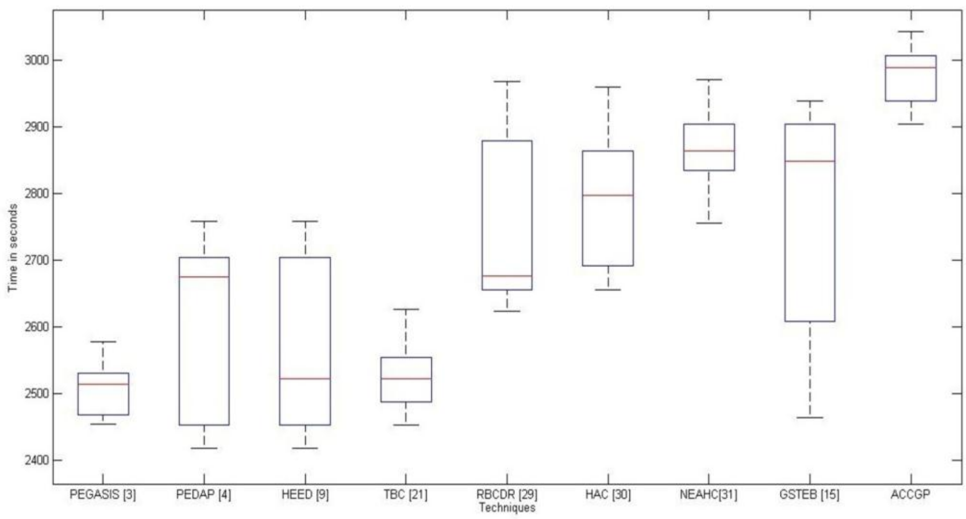

Figure 2. Comparison of the Network Lifetime

Residual energy of a network is the time when last ever node die in the network. Figure 3 represents the comparison of the proposed technique with available one. The figure is cleary indicating that the Residual energy of the proposed technique is significantly improved. Due to random deployment of the sensor network there exist variation in Residual energy whenever simuation is run. But when compared to available protocols, it is found that the Residual energy of the proposed technique is consistent and maximized than available well-known protocols.

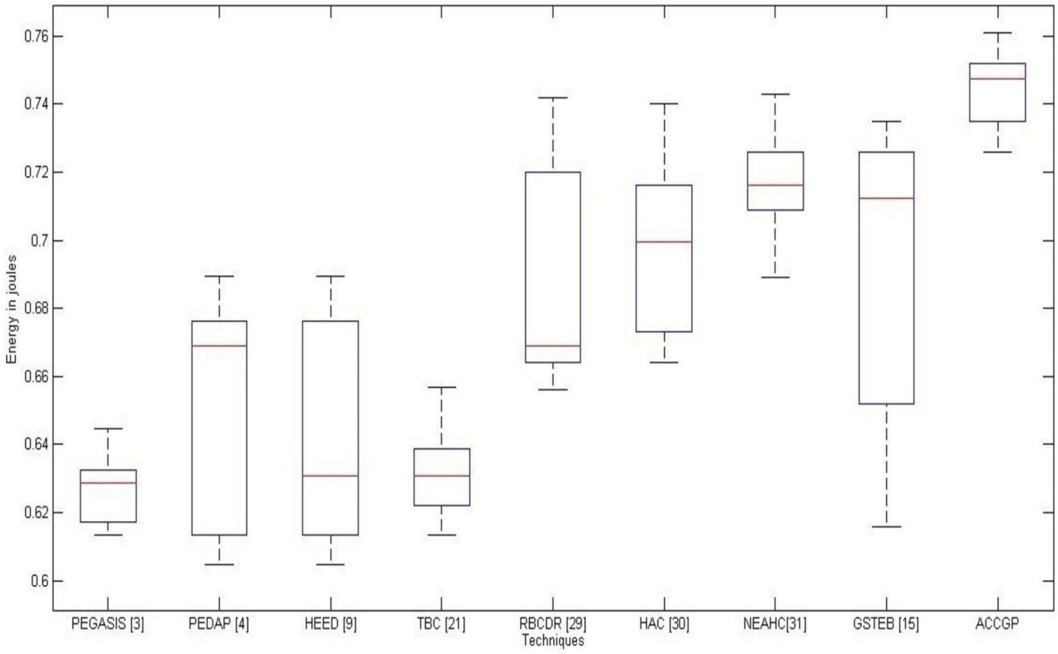

Figure 3. Comparison of the Residual Energy

Throughput of a network is the time when last ever node die in the network. Figure 3 represents the comparison of the proposed technique with available one. The figure is cleary indicating that the Throghput of the proposed technique is significantly improved. Due to random deployment of the sensor network there exist variation in Throghput whenever simuation is run. But when compared to available protocols, it is found that the Throughput of the proposed technique is consistent and maximized than available well-known protocols.

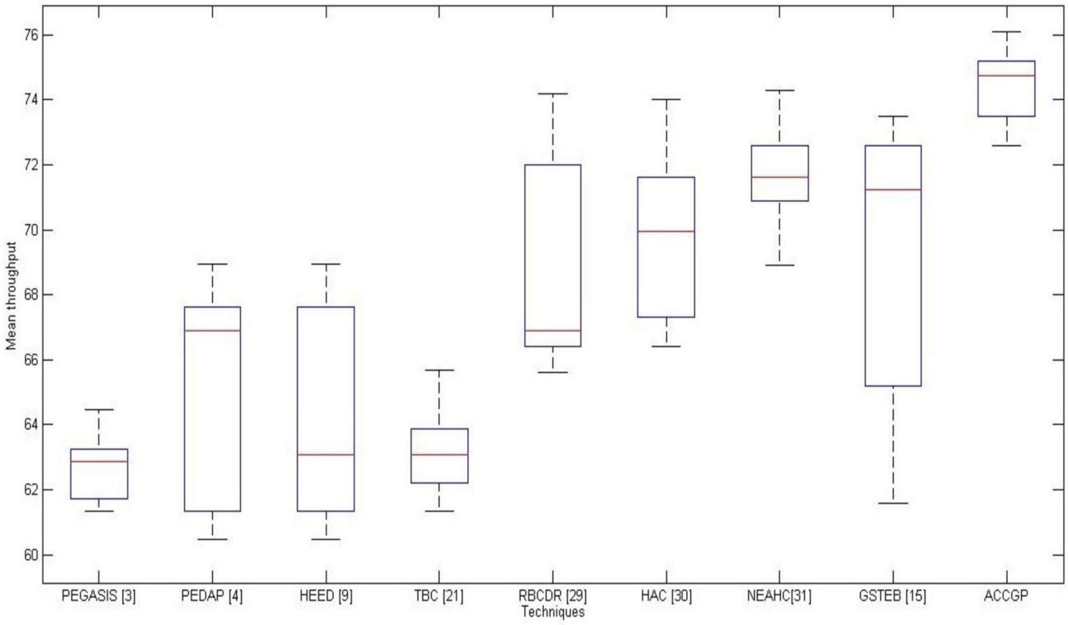

Figure 4. Comparison of the Throghput

6. CONCLUSIONS

The motivation from nature-inspired optimization; this paper proposes an ACCGP protocol which utilizes clustering, ACO and compressive sensing for wireless sensor networks. It decomposes the sensor network into numerous segments thus called clusters, and cluster heads are chosen in every cluster. Then, tree-based data aggregation come in action and collects sensing information directly from cluster heads by utilizing short distance communications. The ACO optimization evaluates the shortest path among sink and cluster heads. The use of compressive sensing reduces the packet size which is going to be transmitted in the sensor network. The MATLAB simulation tool is used for simulation purpose. It evaluates the performance of the proposed technique with existing technique i.e. GSTEB on the following metrics i.e. stability period, network lifetime, residual energy (average remaining energy), and throughput by taking 100 sensor nodes. Other parameters for simulation are adapted from the GSTEB [15]. The sensors distributed arbitrarily in a 100×100 area with the base station at (50m, 150m). Simulation is run ten times and based upon the same, box plots are developed. The simulation analysis shows that the hybrid protocol considerably enhances network lifetime by conserving the energy in the more efficient manner than other protocols at present deployed for sensor networks.

There is no conflict of interest regarding the publication of this paper.

REFERENCES

[1] Nawaz, Faiza, and Shafat Ahmed Bazaz. "Lifetime optimization of Wireless Sensor Network through energy efficient clustering for robust data routing." in 2nd IEEE International Conference on Computer Technology and Development (ICCTD), pp. 235-239, 2010.

[2] Ji, Peng, Yupeng Li, Jingqi Jiang, and Tianbao Wang. "A Clustering Protocol for Data Aggregation in Wireless Sensor Network." In Proceedings of the IEEE International Conference on Control Engineering and Communication Technology, pp. 649-652, 2012.

[3] Lindsey, Stephanie, and Cauligi S. Raghavendra. "PEGASIS: Power-efficient gathering in sensor information systems." *Aerospace conference proceedings, 2002. IEEE*. Vol. 3. pp. 3-1125, IEEE, 2002.

[4] Tan, Hüseyin Özgür, and Ibrahim Körpeoğlu. "Power efficient data gathering and aggregation in wireless sensor networks." *ACM Sigmod Record* 32.4, pp. 66-71, 2003.

[5] Kumar Dilip "Performance analysis of energy efficient clustering protocols for maximising lifetime of wireless sensor networks." Wireless Sensor Systems, IET 4, No. 1, pp. 9-16, 2014.

[6] Li, Nan, Shangru Li, and Xiaozhou Fang. "Adaptive data aggregation mechanism based on leach protocol." in International Conference on Advanced Intelligence and Awareness Internet (AIAI 2010), pp. 131-134, 2010.

[7] Mantri, Dnyaneshwar, Neeli R. Prasad, and Ramjee Prasad. "Grouping of clusters for efficient data aggregation (GCEDA) in wireless sensor network." in 3rd IEEE International Advance Computing Conference (IACC), pp. 132-137, 2013.

[8] Mathapati, Basavaraj S., Siddarama Patil, and V. D. Mytri. "A cluster based Energy Efficient Reliable Routing Protocol for Wireless Sensor Networks." in 2012 1st IEEE International Conference on Emerging Technology Trends in Electronics, Communication and Networking (ET2ECN), pp. 1-6, 2012.

[9] Younis, Ossama, and Sonia Fahmy. "HEED: a hybrid, energy-efficient, distributed clustering approach for ad hoc sensor networks." IEEE Transactions on Mobile Computing, Vol.3, No. 4, pp. 366-379, 2004.

[10] Younis, Ossama, Marwan Krunz, and Srinivasan Ramasubramanian. "Node clustering in wireless sensor networks: recent developments and deployment challenges." Network, IEEE, No. 3 pp. 20-25, 2006.

[11] Liang, Weifa, and Yuzhen Liu. "Online data gathering for maximizing network lifetime in sensor networks." *Mobile Computing, IEEE Transactions on* 6.1, pp. 2-11, 2007.

[12] Manzoor, Basit, Nadeem Javaid, O. Rehman, M. Akbar, Q. Nadeem, Adeel Iqbal, and M. Ishfaq, "Q-LEACH: A New Routing Protocol for WSNs." Procedia Computer Science 19, pp. 926-931, 2013.

[13] Kumar, Dilip, Trilok C. Aseri, and R. B. Patel. "EEHC: Energy efficient heterogeneous clustered scheme for wireless sensor networks." Computer Communications 32.4, pp. 662-667, 2009.

[14] Qureshi, T. N., Nadeem Javaid, A. H. Khan, Adeel Iqbal, E. Akhtar, and M. Ishfaq. "BEENISH: Balanced Energy Efficient Network Integrated Super Heterogeneous Protocol for Wireless Sensor Networks." *Procedia Computer Science* 19, pp. 920-925, 2013.

[15] Han, Zhao, Jie Wu, Jie Zhang, Liefeng Liu, and Kaiyun Tian. "A General Self-Organized Tree-Based Energy-Balance Routing Protocol for Wireless Sensor Network." pp. 1-2, 2014.

[16] Jain, Aarti, and B. V. R. Reddy. "Optimal degree centrality based algorithm for cluster head selection in wireless sensor networks." in Recent Advances in Engineering and Computational Sciences (RAECS), pp. 1-6, 2014.

[17] Nitesh, Kumar, and Prasanta K. Jana. "Relay node placement algorithm in wireless sensor network." in IEEE International Advance Computing Conference (IACC), pp. 220-225, 2014

[18] Samanta, Moumita, and Indrajit Banerjee. "Optimal load distribution of cluster head in fault-tolerant wireless sensor network." in IEEE Students' Conference on Electrical, Electronics and Computer Science (SCEECS), pp. 1-7, 2014.

[19] Rani, Shalli, Jyoteesh Malhotra, and Rajneesh Talwar. "Energy efficient protocol for densely deployed homogeneous network." in International Conference on Issues and Challenges in Intelligent Computing Techniques (ICICT), pp. 292-298, 2014.

[20] Saxena, Madhvi, Neelam Phate, K. J. Mathai, and M. A. Rizvi. "Clustering Based Energy Efficient Algorithm Using Max-Heap Tree for MANET." in fourth IEEE International Conference on Communication Systems and Network Technologies (CSNT), pp. 123-127, 2014.

[21] Kyung Tae Kim, Chang Hoon lyu, Sung Soo Moon and Hee Yong Youn , " Tree Based Clustering(TBC) for Energy Efficient Wireless Sensor Networks." in 24th IEEE International Conference on Advanced Information Networking and Application Workshops ,pp.680-685,2010.

[22] Mohd Shafaat Hussainn and Manoj Yadav , “Optimized Compression and Decompression Software” in the International Journal of Innovative Research in Science, Engineering and Technology (IJSRSET), pp.255-259,2015.

[23] Manoj Kumar Patel, “A hybrid ACO/PSO based algorithm for QoS multicast routing problem” in Shams Engineering Journal, pp. 113-120, 2013.

[24] Gautam N, Sofat S, Vig R, “An Ant Voronoi based clustering approach for Wireless Sensor Networks” ,Springer, pp.32-46, 2014.

[25] Narasegouda S. , “Energy saving model for sensor network using ant colony optimization algorithm” in 2nd Springer International Conference on Soft Computing for Problem Solving SocProS 2012,pp.51-57,2014 .

[26] Ma D, Ma J, Xu P. , “An adaptive virtual area partition clustering routing protocol using ant colony optimization for wireless sensor networks” , Springer, pp.23-30, 2014.

[27] Su Y, Li J, Qin Z, Wang L, Zhang W, “Maximizing the network lifetime by using PACO routing algorithm in wireless sensor networks” , Springer,pp.155-165,2014

[28] K. V. Janaki Raam , K. Rajkumar, “A Novel Approach using Parallel Ant Colony Optimization Algorithm for Detecting Routing Path based on Cluster Head in Wireless Sensor Network”, Springer,pp.1-7,2015.

[29] Liangshan Jiang, Anfeng Liu, Yanling Hu, Zhigang Chen, Lifetime maximization through dynamic ring-based routing scheme for correlated data collecting in WSNs, Computers & Electrical Engineering, Volume 41 , pp. 191-215, January 2015

[30] Tao Du, Shouning Qu, Fangai Liu, Qin Wang, An energy efficiency semi-static routing algorithm for WSNs based on HAC clustering method, Information Fusion, Volume 21, pp. 18-29, January 2015.

[31] Wang Ke, Ou Yangrui, Ji Hong, Zhang Heli, Li Xi, Energy aware hierarchical cluster-based routing protocol for WSNs, The Journal of China Universities of Posts and Telecommunications, Volume 23, Issue 4, pp. 46-52,August 2016.

AUTHOR BIOGRAPHY

Supreet Kaur is a Research Scholar in Punjab Technical University. Her area of research is Wireless Sensor Networks. She has done M-Tech (CSE) from Dav College of Engineering and Technology, Jalandhar (DAVIET) and B-Tech (CSE) from Amritsar College of Engineering and Technology, Amritsar (ACET).

Dr**.** Rajiv Mahajan is working as a Principal at Golden Group of Institutions, Gurdaspur, India. He has various research papers in the field of computer science in some well-known SCI indexed journals. His research areas include Wireless Sensor Networks and Network Security.