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Particle swarm optimization based hierarchical clustering and compressed forwarding based protocol for WSN

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Abstract: Wireless sensor network consist of sensor nodes which are scattered to sense and to gather data & transmit it to Base Station for processing .NEAHC is energy efficient hierarchical routing protocol toward extend lifespan of the network with combination of clustering approach. The major point of associated in this paper is to maximize lifespan of the network & reduce the energy consumption. NEAHC with using PSO algorithm has shown fairly major success more than accessible WSNs protocol. The lifespan of the network has been approved in this paper by hybridizing the compressed sensing and optimization.
Keywords: Wireless Sensor Network, Clustering, Compressing sensing, PSO, NEACH.

Introduction

A WSN is created with "nodes" – by fewer to many hundred or more than hundred, where every single node is attached to a single (sometime more than one) sensor. Every these kind of sensor network nodes have normally various types: a radio transceiver using the interior antenna as well as connection with exterior antenna, electronic digital circuit for interfacing with all sensors as well as an energy source, usually a battery power or an embedded type of energy harvesting. Wireless Sensor Networks gives us an opportunity for various large ranges of applications. Although along with this, there are lots of disadvantages which include limited energy, communication limitations as well as failures of sensor node.

Out of these the main challenge is energy limitation & also increasing the lifetime of network especially in the case of sensors which are deployed in environments similar to battleground security, weather supervision, problem management as they're not easy for access. To remove these types of disadvantages, various techniques have been proposed. Clustering has become significant techniques for increasing the lifetime of network in the WSNs. It calls for grouping of sensor nodes in cluster as well as choosing cluster heads (CHs) for whole clusters. CHs obtain information from particular cluster nodes as well as it send the collected information to base station. WSN base stations have always requires creating an aggregated value towards end users & the aggregation of the data to be sent can help in reducing the transmission overhead and also the energy consumption. To be able to secure the information collection inside the network nodes can be covered in the small groups is known as Clusters. Figure 1.1 represents the basis process of Clustering:

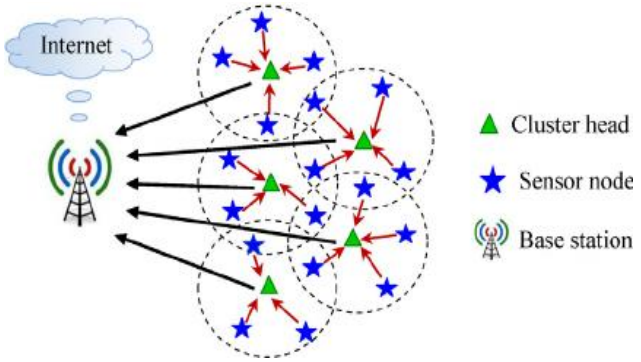

Figure 1.1:- Clustering Process in WSN [5]

Clustering is classified as the section of nodes in small groups of several mechanisms. Clustering is show to increase the network lifetime as well as an analyzing the overall performance of a sensor network. Clustering is done to obtain the overall energy efficiency and also the scalability of the network. Development of the cluster is also involves the working role of the node based on their

perimeters. A manager of the cluster which is responsible for the creating, aggregation as well as transmitting of information to the base station is known as Cluster Head (CH) or maybe leader, while the another nodes that are responsible for sensing as well as sending the obtained information to the CH are known as the Member Nodes. In the clustering two types of hierarchy are used wherein first phase the member nodes sense the information and transmit to the CH and in second phase of CH aggregates and process the information is transmit to the Base Station.

The CH node looses lot of energy as compared to the MN because it executes the combination for the overall collected data and aggregation report is send to the Base station located significantly through the cluster location. In a cluster corporation both the Inter-cluster and Inter-cluster communication takes place. When several sensors are cooperatively observe huge real environment, that they kind of wireless sensor network. Long term network life-time, scalability, load handling are very important requirement of several sensor network applications. Clustering sensor nodes is an efficient way of reaching these kinds of goals. Clustering technique is one of the well-liked systems through which nodes pick a Cluster Head (CH) with regard to communication. All nodes distributed their own information to you to CH where, that collected info as well as post to your Base Station (BS). Only several nodes are widely-used to distribute at large long distance therefore, a lesser amount of energy will be consumed. The primary concept of clustering is usually for reduce the actual traffic of network coming from node to base station. Cluster head is really a node that is reliable for manage cluster, it acquire whole information coming from nodes from the cluster and also communicate with sink.

Technique Used

A.NEAHC Protocol

Within this literature, Author proposed a narrative energy aware hierarchical cluster-based (NEAHC) routing protocol with two objectives: limiting the aggregate power utilization and guaranteeing decency of power utilization between nodes. Display the hand-off node picking issue as a nonlinear programming issue and utilize the property of arched capacity to locate the ideal arrangement. Additionally review the proposed calculation through performing toward the finish of this paper NEAHC protocol used to abuse the network life time or reduce aggregate power utilization. The protocol comprises of set up section and steady state segment. Each non-cluster head node collects sensed information and specifically send it to the cluster head inside its interesting availability agree to TDMA schedule of the cluster. In NEAHC, CH are elected on beginning of outstanding power with some CM (cluster member) nodes with low power switches amongst sleep and dynamic modes are the end goal to adjust power consumption. In NEAHC, power consumption in multi-hop correspondence and fairness among sensor nodes has been upgraded [1].

Another routing technique for WSNs called NEAHC to augment network lifespan using a combine of a clustering approach and an ideal hand-off selection algorithm. The proposal is to decide an ideal routing way from the source to the target by support the highest residual battery control, least power consumption in multihop way, and ideal equality among sensor nodes [1].

B. Particle Swarm Optimization Algorithm

Particle swarm optimization (PSO) is a population based stochastic optimization method for solving continuous nonlinear function Introduced by Kennedy and Elberhart (1995) .It is the simulation of social behaviour of bird flocking or fish schooling. It moves solutions through search space. PSO uses the swarm intelligence concept, which is the property of a system, where the collective behaviour of unsophisticated agents that are interacting locally with theirEnvironment creates coherent global functional patterns. It is very simple in concept, easy to implement and computationally efficient. Unlike GA, PSO does not have operators like mutation and crossover.

PSO is a population based search algorithm and is initialized with a population of random solutions called particles Each particle keeps track of best position in the hyperspace. Furthermore each particle consists of a data representing a solution, personnel best position pbest and velocity value. pbest is the personnel best position of a particle having its co-ordinate in the solution space with the best solution achieved by the particle. Velocity value indicates how much the value has changed. PSO keeps track of three global variables namely target value, global best position gbest and the stopping value indicating when the algorithm should terminate. gbest is the global best value achieved by a particle.

Basic idea behind PSO is to accelerate each particle towards its gbest and pbest positions using a random weighted acceleration. Position of each particle will change on the basis of the i) current positions ii) current velocities iii) distance between pbest and current positions and iv) the distance between gbest and current positions.

C. Compressed Sensing

In WSNs, core purpose of compression is to diminish the power consumption. Sensing testing, calculation, with correspondence is the three procedures, which are generally in charge of the energy expenditure within WSNs.So some system that straight otherwise ultimately reduce individual otherwise additional of the functions even as maintain some necessities (e. g. preconception, difficulty, etc.) be able to measure as compression in WSNs.Compressed realizing (CS) algorithm is an additional perspective into transmission processing especially in favour of information acquisition compressed sensing is an beneficial at whatever point transmission is light in a known basis, dimension is expensive, and count quantity at the authority end is reserved.

LZW compress:

1. Enter all letters in table
2. Initialize string s to first letter of input
3. While any input left
4. Read character c
5. If s+c is in the table
6. s=s+c
7. Else output codeword(s)
8. Enter s+c in the table
9. s=c
10. Output codeword(s)

Related Work

In this section gives brief discussion of work related to techniques for enhancing the energy efficiency for wireless sensor networks.

Heinzelman et al. [1] have discovered a hierarchal, probabilistic, distributed LEACH protocol. It uses distributed and adaptive clustering to enhance the results. It has ability to remove duplicity of data at CH level transmits it to BS. Earlier approaches like Direct Transmission (DTE), Minimum Energy Transmission (MTE), Multi-hop routing, Static clustering contributes a lot toward this direction, but are not ideal with respect to energy efficiency among sensor nodes for WSNs. Gandham et al. [2] deploys multiple mobile base stations for enhancing the network lifetime. In it network lifetime is divided into equal time frames known as "rounds". In the beginning of each round, BSs are relocated. To find the new locality of BSs, an integer linear programming is used. Flow based routing protocol provides energy efficient routing. The concept of deploying multiple mobile sink results in the enhancement of WSNs lifetime. Luo et al. [6] makes the BS mobile, thereby location of nodes closer to them changes with time. Data collection algorithm is optimized, considering BS mobility and multi-hop routing. Liu et al. [7] consider dynamic aspects of the coverage of a mobile sensor network, which can be categorized as specific time instants and detection time of a randomly located target. The results show that by exploiting sink mobility we can reduce detection time of static target. Kumar et al. [9] proposes enhancement in LEACH-Mobile protocol called LEACH-Mobile Enhanced protocol in which only those nodes are selected as CH which has minimum mobility and compares the LEACH-mobile-enhanced protocol with LEACH-mobile. Xing et al. [10] proposed the concept of rendezvous based data collection. This approach consist of subset of rendezvous point, which receives the data from source nodes, then performs the task of data collection and aggregation and finally the

data aggregated will be transferred to MS comes closer to it. The benefit of using this approach is that it helps in network caching, controlled mobility and maintains a balance in saving energy of network and delay in collecting data. This paper presented performance of mobile BSs with fixed and variable location for two efficient rendezvous design protocols.

Proposed Algorithm

The Steps of proposed methodology has been shown below:

***Step* 1**: *Initialize network*

***Step* 2**: *organize network at random within predefined sensor field.*
***Step* 3**: *Be appropriate NEAHC toward estimate points*
When all nodes receive packet, will calculate their own energy − level (EL) by function:

$$EL1'(i) = [Remaining\ energy(io)/\alpha] \quad (1)$$

***Step* 4**: *Apply clustering toward develop cluster heads.*

Node develop into CH in favor of current rotation about but number with a reduction of subsequent threshold

$$T(i) = \{Tn = \begin{cases} \dfrac{F}{1 - F\left[r\ mod\left(\frac{1}{p}\right)\right]} & ;J\ \varepsilon\ K \\ 0 & otherwise \end{cases}\} \quad (2)$$

Error! Book

*Where p*1 *is best for percentage of CHs within each round r′is current node and* i_0 *stand used each node wants to become CH round.*

*G*1′*is set nodes with the intentionof comprise not PSO n selected as CHs in previous* $\frac{i}{P}$ *rounds*

***Step* 5**: *Relate particle swarm optimization on clusters toward discover finest route with CHs to sink.*

Assigning in use PSO to the victuals source:

$$X'(i_0)=x_i'(i_0)\pm r(x_i'(i_0)-x_k'(i_0)) \quad (3)$$

Association of spectator ended via following equations:

Possibility of selecting nectar source:

$$P''_i = F'(\theta_i)/\sum_{k1'=1}^{s''} F'(\theta_{k1'}) \quad (4)$$

$p'_i(\theta_i)$:*The possibility of select ith engaged PSO*

$p'_i(\theta_i)$:*The number of employed fireflies*

$p'_i(\theta_i)$:*The position of the ith in use PSO*

$p'_i(\theta_i)$:*The strength rate*

Calculation the new site:

$$X_{i'j'}(t1'+1) = \theta_{ij}(t1') + \emptyset(\theta_{ij}(t1') - \theta_{kj}(t1')) \quad (5)$$

$x_i' = The\ position\ of\ spectator\ PSO$

$T1$: *Iteration number*

θ_k: *Randomly selected in use particles*

Evaluate the velocity of particles by

$$v = \frac{\partial \delta}{\partial t}$$

$J1:$ *Dimension of explanation*

$\emptyset\left(\theta_{i'j'}(t1) - \theta'_{k1'j}(t1)\right):$ *A series of random variable in the range .*

Association of the explore particles

Movement of explore particles follows equation

$$\theta_{i'j'} = \theta_{j'min} + r.(\theta_{j'max} - \theta_{j'min}) \quad (6)$$

r 1: *Accidental quantity and* $r1 \in [0,1]$

Step 6: *Evaluate and update energy consumption.*

$$d1'_{to\ CH} = \frac{M1}{\sqrt{2\pi k1}},\ d'_{toBS} = 0.765\ \frac{M1}{2} \quad (7)$$

$$E_{tx1}(l'', d1') = \begin{Bmatrix} l''E_{elec1} + l\varepsilon_{fs} & d^{1''2}; d1'' < d1''_0 \\ l''E_{elec\,1} + l\varepsilon_{fs} & d^{1''2}; d1'' \geq d1''_0 \end{Bmatrix} \quad (8)$$

Where

$$d1_0 = \sqrt{E_{fs1}/E_{mp\,1}} \quad (9)$$

M is area of WSN

E_{fs1} *is magnification power of liberated space*

$E_{mp\,1}$ Error! Bookmark not defined. *is augmentation power while region is extra.*

Step 7: *confirm whether every nodes turn into dead, condition yes subsequently illustrate network life span with come again as well maintain to step* 3.

$$Dead = \begin{Bmatrix} 1 & if s(i).Energy \leq 0 \\ 0 & otherwise \end{Bmatrix}$$

$$\text{Termination} = \begin{Bmatrix} 1 & if\ count\ dead1 == n1 \\ 0 & otherwise \end{Bmatrix} \quad (10)$$

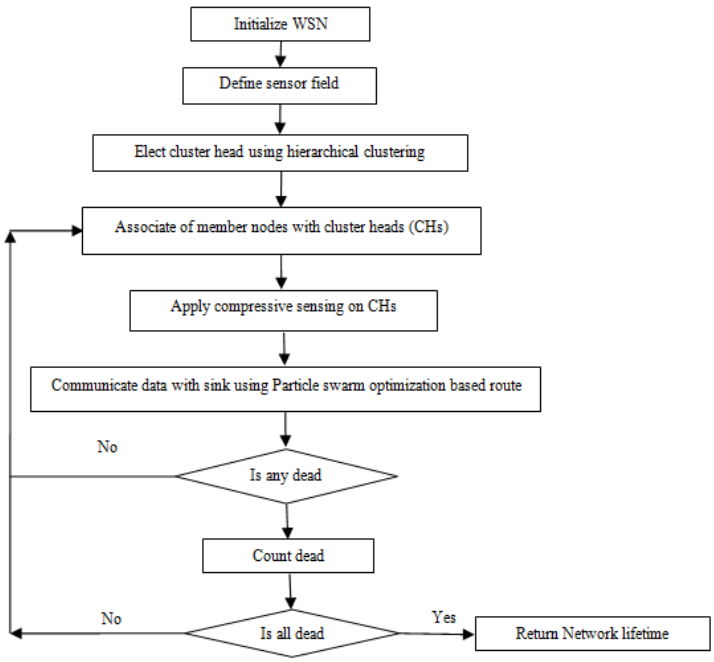

Figure.1.2: Proposed flow chart with PSO

Result and Discussion

The proposed algorithm will be considered from the energy enhancement with PSO algorithm using NEAHC protocol applying dissimilar constraints including Packets sent to BS, and packet sent to CH. The subsequent data demonstrates the comparison regarding response to diverse parameters. The result demonstrates the proposed solution provides improvement over active approaches. After the results, we compared the proposed solution against the current procedures.

Table 1: Simulation parameters

PARAMETER	VALUE
Area	100*100 m
Base station	50,150
Nodes	200
Probability	0.1
Initial energy	0.01(in joule)
Transmitter energy	50 (in joule)
Receiver energy	50 (in joule)
Message size	4000 (in bits)
Fraction of Advance node	0.3 (in fraction)
Data aggregation energy	5 (no. of joule)
Amplification energy	0.0013 (in joule)
Maximum lifespan	4000 (sec/round)

The result demonstrates the proposed solution provides improvement over active approaches. Following are the various performance metrics that are desired by different types of users and providers:

A. Packet Sent to Base Station

It obviously shows that numbers of rounds for Packet to BS in case proposed are extra than Existing NEACH Protocol. Bar graph clearly shows that the number of rounds for the packet send to BS in case of proposed PSO with NEAHC is extra than Existing NEAHC .

Table 2:Packets sent to Base Station

No.	No. of nodes	NEACH	CPNEACH
1	100	1.3211	1.3634
2	120	0.9281	1.3656
3	140	1.1579	1.5436
4	160	1.2810	1.6053
5	180	1.5529	1.5608
6	200	1.5418	1.6527
7	220	1.5998	1.6700
8	240	1.4833	1.6976
9	260	1.4110	1.6158
10	280	1.5347	1.5535
11	300	1.6060	1.6658

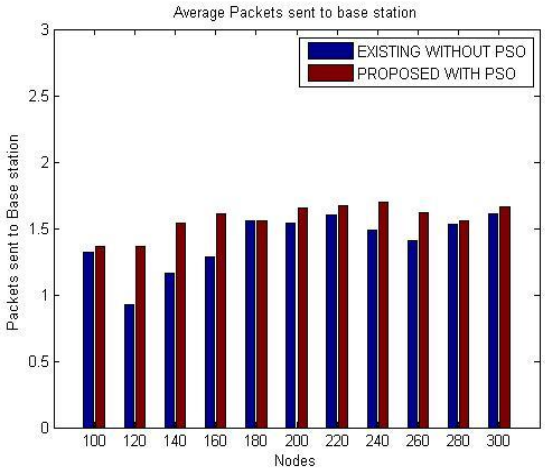

Figure 1.3: Packets sent to Base Station

B. Packet Sends to Cluster Head

Bar graph clearly shows that the number of rounds in favour of packet send to CH in case of proposed PSO with NEAHC extra than Existing NEAHC. It obviously shows that the numbers of rounds for Packet to CH in case of the proposed are more than the Existing NEACH protocol.

Table 3: Packets sent to Cluster Head

No.	No. Of nodes	NEACH	CPNEACH
1	100	14.4802	15.7673
2	120	10.4086	15.7774
3	140	13.0387	17.6874
4	160	14.2239	18.3445
5	180	16.6946	18.0958
6	200	16.8141	18.1603
7	220	17.0806	18.9182
8	240	16.4986	19.0814
9	260	15.4977	18.1854
10	280	16.9578	17.6556
11	300	17.2382	19.0114

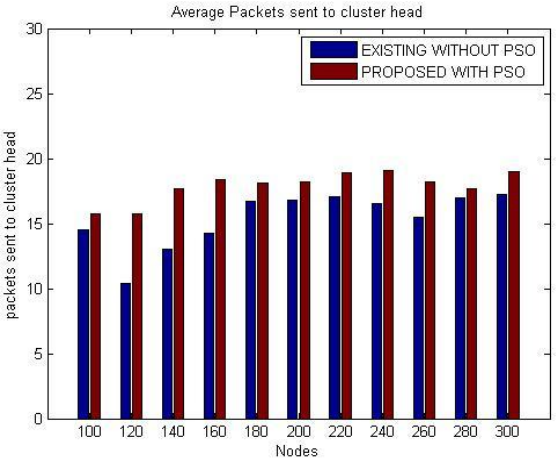

Figure.1.4: Packets sent to Cluster Head

Conclusion and Future Scope

In this paper a novel hybrid approach has been used to improve the energy of exiting NEAHC and PSO with NEAHC algorithm. We have enhance the existing Novel energy aware hierarchical cluster based (NEAHC) routing protocol to minimize the total energy consumption & fairness of energy utilization between the nodes. In many of the earlier approach the lossless compression has been neglected by the most of the researchers .The proposed method has been designed as well as implemented in MATLAB 2013 wireless data analysis toolbox. There are various parameters that have been considered for experimental purpose i.e. Packet sends to CH, packet sends to BS. The comparison has demonstrated that the algorithm provides optimal path between the nodes due to the energy utilization between the nodes is more while transferring the data. The proposed technique outperforms the existing technique. In near future to enhance further by using the different optimization techniques like butterfly optimization, Gray wolf optimization etc., as well as also consider the other compressed sensing technique which will also be considered to reduce the energy utilization rate further.

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