RESEARCH ARTICLE OPEN ACCESS

Enhanced New Improvement Algorithm in WSN with Efficient Transmission for Energy-Saving

Anita Chandra*, Manish Kumar**
*(School of Computer Engineering, KIIT University, Odisha, India)
**(School of Computer Engineering, BPUT University, Odisha, India)

ABSTRACT
The Coverage problem is very eminent and tough to maintain in WSN. This paper firstly finds out redundant nodes using classical Coverage Preserving Nodes Scheduling Scheme (CPNSS) algorithm and Sponsor Sector Based Off-duty Eligibility Rule of the WSN. We propose an Enhanced New Improvement Algorithm (ENIA) which focuses on the problem of CPNSS low efficiency and energy unbalance and save the extensive amount of energy of network. Here sensor nodes are grouped to form several independent sets and each set can cover all the area of the WSN. The Set having the largest average energy becomes the working node of particular portion of an area. Based on both residual energy and distance to base station, a Main M-working-Set is chosen among all working-sets**.** So, The Sets having the largest energy residual and minimum distance will communicate to base station without involvement of other working sets. Therefore this leads to energy-saving, congestion-control and reduced overhead at base station.
General Terms - Energy balance, Energy saving, Efficient transmission
Keywords -WSN; Coverage; Redundancy; Energy-balance; Average energy; Distance

I. INTRODUCTION

Recent technological advances allow us to visualize a future where large numbers of low-power, inexpensive sensor devices are densely embedded in the physical environment, operating together in a wireless network. There is wide applications of these wireless sensor networks categories as ecological habitat monitoring, structure health monitoring, environmental contaminant detection, industrial process control, and military target tracking, among others .Presently there are many algorithm on energy-preserving in WSN [1,2,3,4,5,6,7].Document [1,2] says the scheme of energy preserving through maintaining original coverage after removable of some redundant nodes. The scheme adopts a way of eliminating redundant node and this will prolong the lifespan of network with efficiency, but it just emphasizes the local energy saving control. However, the algorithm doesn't deals with problem coming in the dormant nodes efficiently. SO further it has the problem of energy unbalance and low-efficiency in network. Document [3,4,5,6,7] have different form of protocols for ad-hoc and WSN network which assume dynamic changes in connectivity but not frequent node failures, PEAS [5] works in a harsh working environment in which node failure phenomenon is frequent. Other existing energy-saving protocols are GAF [6], SPAN[3] ,AFECA[4]. Document [1] proposes scheme for detection of redundant node geometrically using CPNSS algorithm. It causes energy imbalance as all nodes are active at the same time. Document [1] proposes scheme for detection of redundant node geometrically using CPNSS algorithm. It causes energy imbalance as all nodes are active at the same time.

So, this paper proposes a Enhanced New Improvement Algorithm (ENIA) of Coverage-preserving Control based on set theory and efficient transmission of information to base station through M-working set(Main).

II. CPNSS CLASSICAL COVERAGE PRESERVING NODE CHEDULING SCHEME ALGORITHM

The word **redundancy** stems from the Latin verb “redundare“ that means overflow. **Redundancy** is the provision of additional or duplicate resources, which can produce similar results. Redundancy should be eliminated to save energy, conflict and communication overhead. CPNSS algorithm is based on finding the optimum number of node by eliminating redundant nodes and makes sure original coverage without any sensing hole or blind point. It can be implemented, with each node making sure of it's situation that it can be closed by it's neighbors and inspecting neighbors whether they can help it cover all the areas. if original node inspect that it can be covered by its neighbors it will turn off.

The basic idea of CPNSS is as follows:-

2.1 The Centre Distance Algorithm
CPNSS algorithm makes the following definitions:

Defination1 The node distance :-
For two random nodes A and B the node's distance from node A (x_a, y_a) to node B(x_b, y_b) have following formula:

$$d(a,b) = \sqrt{(x_a - x_{b)}^2 + (y_a - y_b)^2} \quad (1)$$

Defination2: The neighbour-node sets:-
Considering the sets of sensor nodes $\{S_1, S_2, S_3 \ldots S_m\}$ We presume that the sensing radio is r in the limited area A.
Then the neighbour-node set of node *i* shown as following:-

$$N(S_i) = \{n \in N \mid d(S_i, S_j) < r, S_i \neq S_j\}$$

If the total exploratory $[0, 2\pi]$ of node S_i was covered by its neighbour N (S_i), then it would be said to be redundant node..
The following part shows precisely and proves it geometrically:

As shown in figure F1:

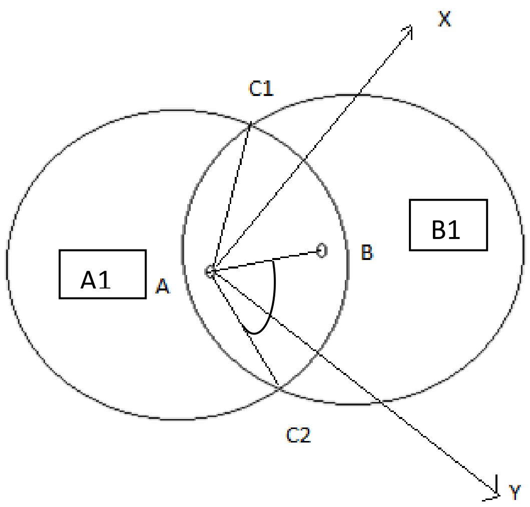

Fig.1 Open Angle

The open angle of neighbors B to A is ∠C1AC2 recorded as *∠B->A.* In order to calculate opening angle ∠C1AC2 we take two angles
∠BAX = α (It is angle between distance between two sensor centre and benchmark axis **x or y axis**)
∠BAP2 = β (It is angle between distance between centre of two sensor and intersection points of sensor C1, C2 from A)

Then the open angle is [α-β, α+β] because of α-β<0. So, open angle is $[0, \alpha+\beta] \cup [2\pi + \alpha - \beta), 2\pi]$.Before each node evaluates its open angle, first it should calculate the angle between it and the benchmark axis. If the set of the open angle is between all the neighbors of node A and covers $[0, 2\pi]$, then node A is said to be a duplicate node.
here,

$$\alpha + \beta = \angle BA\,C2$$
$$\alpha - \beta = \angle YAB \text{ or } \angle BAX \text{ as } \alpha - \beta < 0$$

So, $\alpha - \beta = [2\pi + \alpha - \beta), 2\pi] = \angle XAC2$ OR $\angle C1AY$
Therefore, open angle is given as:

$$\angle C1AC2 = \angle BAC2 + \angle C1AY \quad (2)$$
or
$$\angle BAC1 + \angle XAC2$$

Now, we can say that,

$$\cup_{a \in N(b)} N \;\beta_{a->b} = [0, 2\pi] \quad (3)$$

So, α and β can be calculated as :-
Suppose co-ordinate of sensor networks A and B are as A $(x_a, y_a)$and B(x_b, y_b) respectively.
α is given as:-

$$\alpha = \tan^{-1} y_a - y_b / x_a - x_{b)} \quad (4)$$

And,
β is given as:-

$$\beta = \cos^{-1} \sqrt{(x_a - x_{b)}^2 + (y_a - y_b)^2} / 2.r \quad (5)$$

So, like these redundant nodes are observed and then turned off to conserve energy, this avoids duplication or conflict of information and reduce overhead. But this geometrical and classical preserving node scheduling algorithm is for limited WSN.

III. REDUNDANCY DETECTION USING SPONSORED COVERAGE CALCULATION

In this section, we will examine that how a node found that its neighbors can overlap its sensing range over the give network area. Two things are taken in consideration are: i) WSN is fully localized ii) Sensing Range (r) is same for all nodes.

As discussed earlier, the main purpose of this algorithm is to optimize the number of working node by removing redundant nodes, as well as maintain the original sensing coverage free of blind point. To achieve this goal, we evaluate each node's sensing area and then it is compared with its neighbors. If the whole sensing area of a node is fully covered by the union set of its neighbors i.e. neighboring nodes can cover the current node's sensing area, this node can be turned off and considered to be redundant without reducing original coverage.

We will see how this algorithm works diagrammatically:

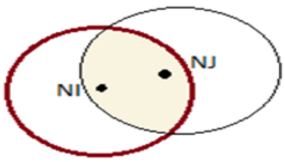

Fig 2a. S(j) ∩ S(i)

Intersection of two sensor S(j)∩S(i) will give crescent-shaped intersection and it is difficult to calculate.

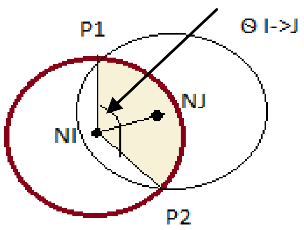

Fig 2b. $S_{j->i}$ And $\theta_{j->i}$

Since the area of crescent is larger than that of the sector , it is much easier to calculate sector area because the area of a sector can be represented by its central angle denoted as $\theta_{j->i}$ precisely.

Sponsored sector by neighbors:
$S_{j->i}$ is denoted as sponsored area by neighbor j to node i and it is calculated using central angle of sector $\theta_{j->i}$.

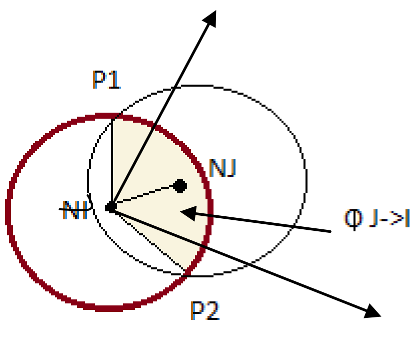

Fig 2c. $\Phi_{j\to i}$

$\Phi_{j\to i}$ give direction of node j with respect to node i. we can get location information of neighbors from $\Phi_{j\to i}$.

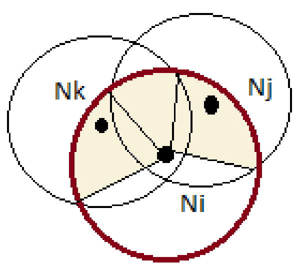

Fig 2d.$S_{j\to i}$ ∪ $S_{k\to j}$

Three nodes are N_i, N_j , N_k are taken. Fallowing conclusion can be seen from above figure.
If $S_{j\to i} \cup S_{k\to j} \supseteq S_i$ then $S_{j\to i} \cap S_{k\to j} \supseteq S_i$
Both union and interection of sopnsored setor of two different neighbor of node i is subset of sensing range S(i) of node i.

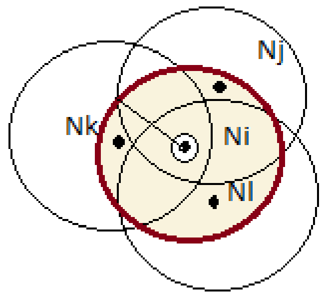

Fig 2e. $\cup\ S_{j\to i} \supseteq S(i)$

Union of sponsored sector or area $S_{j\to i}$ $S_{k\to i}$ $S_{l\to i}$of all neighbors of node i is equal to 360^0.hence node i is considered to be redundant.

Minimum three neighbors nodes are required for being a node to be redundant .So, like this we detect redundant node using preserving coverage node scheduling scheme for large network.

IV. THE PROPOSED ENHANCED NEW IMPROVEMENT ALGORITHM

In the CPNSS algorithm, when power of active nodes have ran out that would lead to the problem of energy imbalance in distributing the nodes. Here energy of nodes ran out as all nodes are active nodes at same time .So, we proposed Enhanced New Improvement Algorithm (ENIA) some enhancement in classical CPNSS for Energy-balance.

The basic idea of Enhanced New Improvement Algorithm is as follows:

The ENIA uses concept of set theory in which all sensor nodes are divided into in which all sensor nodes are divides into a certain number of independent sets, and each set can cover the portion of entire sensor network areas alone.

According to the present average energy of each individual independent set, we evaluate a weight A_e average energy. Sets having highest A_e will become working set and other sets are dormant for particular area of network. So, only one set are responsible for information gathering and all are in inactive state. This can save a large amount of energy of network and avoid some unnecessary conflicts at the same time.

NIA goes through three different phases:-
1) Formulation of independent Sets.
2) Selection of Working sets.

3) Transmission of data to base station from M-working node (Main).

These phases are broadly described diagrammatically

4.1 Formulation of independent sets from all nodes of network.

Initially we take help of CPNSS algorithm for determining the first independent node-sets it must be free from redundant nodes.Again we use CPNSS algorithm to determine the second independent node-set, and so on, Until all the working node sets have been grouped. Number of nodes in Sets is called as degree of set and it can be different for different Sets.

The total number of sensor nodes: S={$n_1, n_2, n_3 \ldots n_n$}
The degree of set= $|S_j|$
The independent sets are as:-

$$S_j = \{\ n_i \in S, 1 \leq i \leq N\ \} \quad (6)$$

i.e

$$1 \leq j \leq M$$
$$|\ S_j\ | \neq |S_{j+1}\ |$$

It is not necessary that degree of all sets are equal.

Formulated Sets posses two properties:-

$$S_1 \cup S_2 \cup S_3 \cup S_4 \cup \ldots \ldots \ldots S_n = S \quad (7)$$

$$S_1 \cap S_2 \cap S_3 \cap S_4 \cap \ldots \ldots \ldots S_n = \emptyset \quad (8)$$

we have,

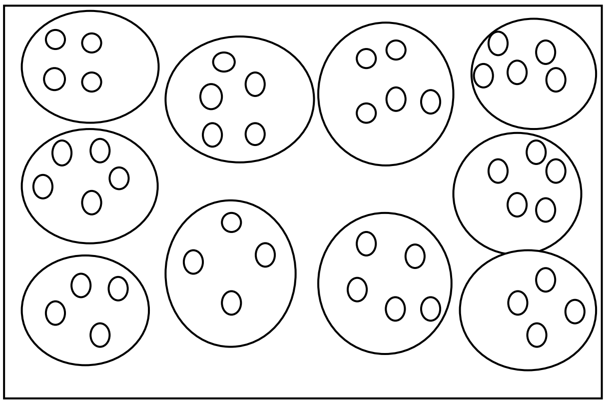

Fig 3.Independent Sets

4.2. Selection of working sets based on average energy of sets:

Average energy of each independent set is calculated as:-

$$A_e = \frac{\sum_{n_i \in S_j}^{n_i} E_i}{|\ S_j|} \quad (9)$$

A_e= Average energy
E = Initial energy of each node
S_j = Degree of the set j

The independent set who is having greatest average energy value will become working-set and other are considered as dormant set at particular portion of area A. In order to the wastage of energy and stimulate the sensor energy to achieve balance, which prolongs the lifespan of the sensor network till last.

4.3. Transmission of data to base station form M-working Set (Main Set)

After the formation of Working-Set, we select M-working set from the all other working Set based on the residual energy and distance from the base station of working-set, This decision is made basing on a value λ as follow.

$$\lambda = \frac{E_{residual}}{|d_{MB}\ |}$$

λ = It is ratio of residual energy of Working-Sets And distance of working sets to Base Station.

$E_{resuidal}$ = Residual energy of working sets

d_{MB} = Distance between all M-working-Sets to Base Station

λ is only calculated among Working-Sets for all portion of Sensor Network with respect to distance of Working-Sets to Base Station. The working Set having biggest value of λ will become M-working Set and final transmission of information is done by it to base station other working node that are not chosen to transmit data directly to base station will send information to M-working set after information collection from all nodes of it's set. Instead of direct communication to Base Station from different Working sets of different portion of network Area that is very distant-working Set will aggregate the information from all others working Sets and transmit the fusion data to BS.

As distance between M-working Set and base station is less. So considerable amount of energy will be saved through transmission with M-working Set.

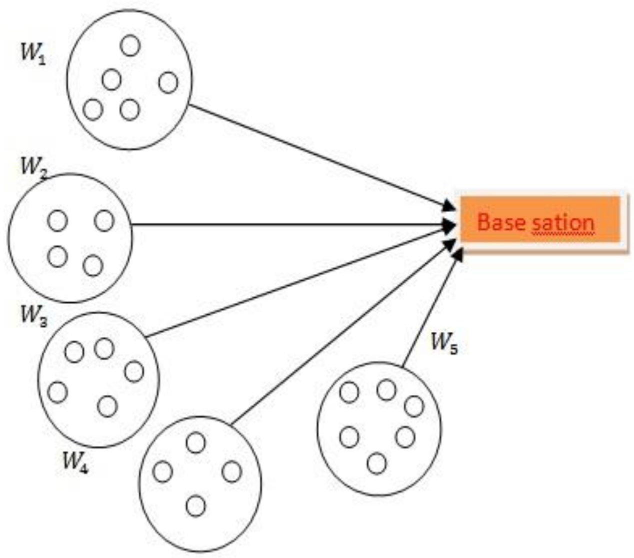

Fig 4. Existing model of NIA

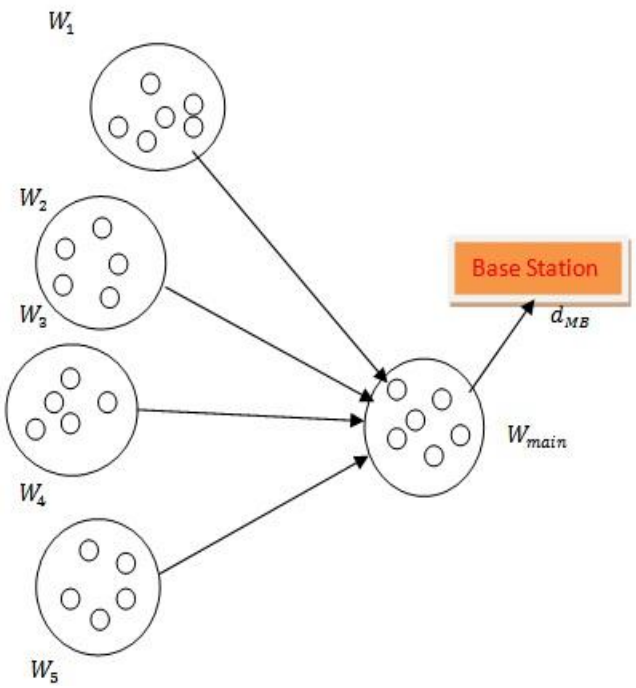

Fig 5.Proposed NIA

So, considerable amount of energy will be saved through this efficient transmission with M-working Set and reduce communication overhead at base station.

V. THE PROPOSED ENHANCED NEW IMPROVEMENT ALGORITHM

The steps of Enhanced New improvement algorithm are:-

[1] Given sensors nodes S($n_1, n_2, n_3, ... n_n$).Form independent Set $S_1, S_2, S_3 .... S_n$ using CPNSS Algorithm.

$$S_j = \{ n_i \in S, 1 \le i \le N \}$$

i.e.

$$1 \le j \le M$$

$$| S_j | \ne |S_{j+1}|$$

[2] i.e.,

$$S_1 \cup S_2 \cup S_3 \cup S_4 \cup \dots \dots \dots S_n = S$$

$$S_1 \cap S_2 \cap S_3 \cap S_4 \cap \dots \dots \dots S_n = \emptyset$$

[3] Evaluate average energy A ($A_1, A_2, A_3 \ldots A_g$) for all Independent sets.

$$A_g = \frac{\sum_{n_i \in s_j}^{n_i} E_i}{|S_j|}$$

[4] Sets having largest weight A_g L is considered as working sets($W_1, W_2, W_3 \ldots W_k$) for different portion P($P_1, P_2, P_3 \ldots\ldots P_a$) of Area A and others are taken dormant sets.

[5] If $\lambda = \frac{E_{residual}}{|d_{MB}|}$ of node are highest then it is called as M-Working- Sets.

[6] All Working-Sets W_i will send information to M-Working-sets and it will send data to Base Stati Without involvement of other Working-Sets.

VI. CONCLUSION

The paper improves the classical CPNSS algorithm in which we grouped the sensor nodes of wireless network into a certain number of independent sets based on the idea of set theory. It define a weight function A_g based on the average energy of the sets and also define λ value which is ratio of residual energy to distance of Working-sets to base station. So we selects a proper set according to weight A_g and λ value through which we can reach the goal of balancing the node-energy and prolonging the lifetime of network and reduce overhead at base station.ENIA can basically solve the problem of low efficiency and energy-unbalance in CPNSS algorithm and congestion control by efficient transmission to base station from M-working sets in existing NIA.

VII. ACKNOWLEDGEMENT

This work was supported by KIIT University, Bhubaneswar, India. Our thanks to experts Asst. Prof. Nachiketa Tarasia, Prof. M.N. Das and Nitesh kumar Singh for their valuable suggestions during various discussion sessions.

VIII. REFERENCES

[1] Yang Tao, Lian-yong Yuan, Ya-li Wang. Optimized Coverage Algorithm in WSN Based on Energy Balance. IEEE 2008

[2] Detain, N. D. Georgians. A Coverage-preserving Node Scheduling Scheme for large wireless sensor networks. ACM Int'l Workshop on Wireless Sensor Networks and Applications (WSNA), pages 32–41, 2002

[3] B.Chen,K.Jamieson,H.Balakrishnan and R.Moris. SPAN: An Energy Efficient Coordination Algorithm for Topology Maintenance in Ad Hoc Warless Network MOBICOM 2001

[4] Y.Xu, J.Heidemam, D.Destrin.Adaptive Energy-Conserving Routing for Multichip Ad Hoc Networks.USC/ISI Research Report527, October, 2000

[5] Ye F, Zhong G, Cheng J, Lu SW, Zhang LX. PEAS: A robust energy conserving protocol for long-lived sensor networks. In: Stankovic J, Zhao W, eds. Proc. of the Int'l Conf. on Distributed Computing Systems (ICDCS). Providence: IEEE Press, 2003.28 37.

[6] Sinchan Roychowdhury, Chiranjib Patra. Geographic Adaptive Fidelity and Geographic Energy Aware Routing in Ad Hoc Routing. Special Issue of IJCCT Vol.1 Issue 2, 3, 4; 2010 for International Conference [ACCTA-2010], 3-5 August 2010

[7] Mortaza Fahimi Khaton Abad P1P , Mohammad Ali Jabraeil JamaliP 2.LEACH Algorithm for Wireless Sensor Network. IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 5, No 1, September 2011 ISSN (Online): 1694-0814 www.IJCSI.org