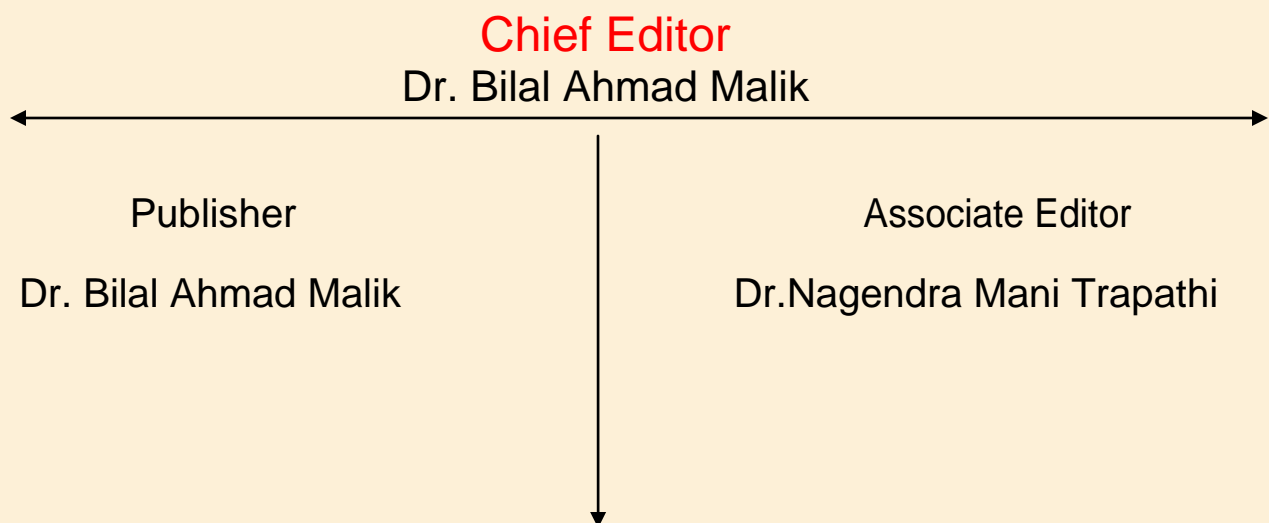


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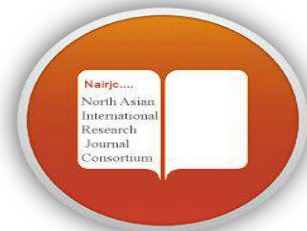
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ISSN NO: 2454 -7514

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Implementation and Advancement of LEACH Protocol using NS2

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ABSTRACT

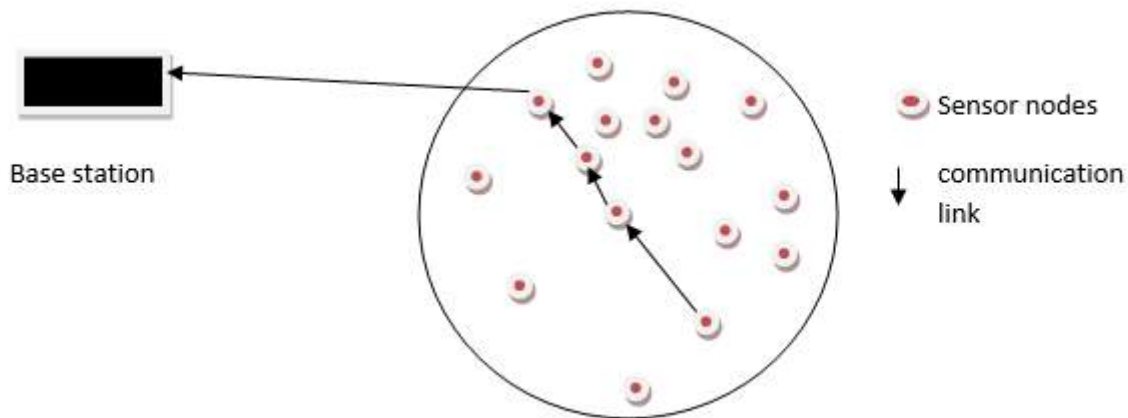
Energy utilization of the sensor nodes is a major challenge that is being encountered in low-powered Wireless Sensor Networks (WSNs) when designing an algorithm, protocol or hardware. Based on the existing LEACH protocol, a new clustering protocol for wireless sensor networks is proposed in this paper. The outcome of this work would be reduction in the energy consumption for sending the sensed data from sensor deployment place to the base station. In our scheme, cluster head election criterion will be based on residual energy and distance using enhanced PSO (Particle Swarm Optimization Algorithm). In this algorithm the clustering head selection will be done with minimization in energy consumption of WSNs. The main objective of proposed design is to apply the LEACH protocol for identifying the energy consumption of each node and also to identify the shortest path to reach the destination. The simulation of the proposed protocol for data collection is done using NS2 simulator.

INTRODUCTION

In Wireless Sensor Network large number of sensor nodes are organized in the form of clusters. The main aim of these sensor nodes is to communicate with the neighboring nodes and transmit the data collected to the base station. These nodes are organized in such a way that they are able to sense, observe and recognize the real world entities. A wireless sensor network can consist infinite no. of nodes that can communicate in the vicinity of the network and also with the base station which is present external to network. These sensor nodes are associated with various features which includes small size, low cost, easy availability and multi functionality. These sensor networks are limited to certain energy constraints. Energy efficiency is an important issue in designing the network topology that affects the life time of the sensor nodes. These sensors node are deployed in various remote areas that makes it difficult to recharge the power source of these sensors nodes. However various researches are

ongoing for preserving energy resources of the sensor nodes in order to extend the life time of the sensor nodes. Hence, energy consumption minimization and extending life time of the sensor nodes is the present challenge in designing the wireless network.

Below figure is **General Cluster Architecture** –



Transmitting the sensed data can be done in various methods includes: Single hop transmission, Multi-hop transmission, cluster based, Tree based and Chain based transmission. LEACH (Low energy adaptive clustering hierarchy protocol) protocol is one of the cluster based protocol. In these protocol each node have chance to become a Cluster Head(CH). There are various algorithm for efficient data gathering and transmission but clustering method of data aggregation results in better life time as it reduces data redundancies. Generally in clustering network the sensor nodes are grouped in clusters and these nodes sense the data and sends its respective Cluster Head(CH). Cluster Head(CH) aggregates the data and aggregated data is transmitted to base station. In clustering the main aim is Cluster Head(CH) election criteria. In these paper PSO (Particle Swarm Optimization) algorithm is used to cluster head election. Various parameters like position of the nodes, velocity are consider in order for the efficient selection of the cluster head.

A. RELATED WORK

In the past few years many researchers have been going on data aggregation and transmission, there are various routing existing protocols for the purpose transmission and routing. Some of them are listed below:

1. LEACH:

It is a self-organizing cluster based protocol. These protocol includes random selection of the Cluster Heads (CH). These election is based on the energies of the sensor nodes. The node with higher energy is selected as a Cluster Head. Due to these there is improvement in overall network life time. In these protocol each node uses stochastic algorithm for each round for determining whether it can be a Cluster Head or not. So each node has $1/p$ probability of becoming a Cluster Head in each round. These selection is done on random basis which do not guarantee even distribution of sensor nodes in network. These leach protocol works in various phases:

- a) **Advertisement Phase:** In these each node selects the random value in between 0 to 1. If the chosen value is less than the threshold value $T(n)$ then that node is elected as a CH for particular round.

$$T(n) = \begin{cases} p/\{1 - p (r \bmod(1/p))\} & \text{if } n \in G \\ 0 & \text{else} \end{cases} \text{-eq 1)$$

Threshold value can be calculated using Eq.1. where,

- (1) n - number of nodes
- (2) p - desired percentage of a node to become a CH
- (3) r - current round nodes

Which has not become as CH in the past $1/p$ rounds which is represented as G [4]. CHs then advertise the election by broadcasting an "Adv_message"

- b) **Set Up Phase:** In this phase the Cluster Head (CH) informs all the nodes in the Network of being cluster head these is done by using CSMA MAC protocol and these procedure is recursively followed.
- c). **Steady Phase:** In these phase the CH allots a Time schedule for each node for sending the sensed data. This is done by using TDMA protocol. Each node transmit the data to its CH in that time slot. After receiving the data from the nodes CH aggregates the data and sends to the base station.

1.1. Short comings of Leach protocol:

- Each node is having the same probability of becoming the cluster head. Due to these if low energy node becomes CH frequently energy of that node will be depleted faster and there may be chance of collapsing of the node.
- It follows uneven Distribution of CH in each region. It may lead to some of region with more cluster head as selection is done in random basis.
- Cluster Head uses single hop routing for communicating with the sink nodes or the base station. If the distance between the cluster head and the base station is larger than the cluster head may consume more energy. Which indirectly effects the efficiency of the entire network.
- The entire network topology is limited to two hop .Due to this large scale demands would not be met.

2. BASE-STATION CONTROL DYNAMIC CLUSTERING PROTOCOL (BCDC):

It is a centralized routing protocol with base station as an essential component. These component is associated with high computational abilities and These protocol also works in various phases:

a) Set up phase: This phase again consist of various phase:

1. Cluster head election
2. Cluster formation

b). Data communication phase: This phase also includes:

1. Data aggregation
2. Data transmission

This protocol includes creation of equal size clusters in order to avoid cluster head overload and to ensure power dissipation of nodes.

3. POWER-EFFICIENT GATHERING IN SENSOR INFORMATION SYSTEMS (PEGASIS):

PEGASIS is a chain based protocol routing scheme. One of the key problem for WSN is energy efficient routing algorithm because energy of sensor nodes is limited PEGASIS uses greedy algorithm to organize

nodes in chain, due to these each node can receive or transmit to only one of its neighbor node in each round. In every round a randomly chosen node will transmit the data to the base station and thus it reduces the no. of nodes communicating directly with the base station.

4. OPTIMIZED ENERGY EFFICIENT ROUTING PROTOCOL (OEERP):

It is a cluster based routing protocol which works under the principle that makes uniform battery drainage of the sensor nodes. The working of this protocol is in various phases:

- a) **Cluster Formation Phase:** In this phase the cluster head election is done. This election is done on random basis .once the CH is elected it sends an Advertisement message to all the sensor nodes. The nodes receiving the advertisement message sends the reply message with the request message for joining under particular CH. In these phase some of the nodes are left out nodes. These nodes are called as individual nodes. But such nodes may become member or even Cluster Head of any other cluster. Thus this individual nodes keep on varying from time to time which helps in maintaining the energy of the sensor nodes. Though it is energy efficient it is having several drawbacks.
- b) **Information Processing phase:** In this phase the sensed data by the sensor node is transmitted to the respective Cluster Head where it is aggregated and then it is send to base station. This process takes place recursively over a period of time.
- c) **Data Dissemination phase:** The aggregated data send by each of the CH of respective cluster to the base station is based on data dissemination interval. Even though the individual nodes keep on changing from one time interval to other then also there are several drawbacks related to this protocol. The various protocol listed in this sections are energy efficient but there is major limitation in cluster formation is the cluster head selection. In order to eliminate such problems, the concept of PSO i.e. Particle Swarm Optimization are used for clustering formation.

B. SYSTEM MODEL

In our proposed work we consider two tier WSN in which K cluster Heads from N sensor nodes and one base station. Each sensor node has unique id and belongs to only one cluster. Nodes performs sensing task periodically and always has data to send to the Cluster Head. All nodes are stationary and energy constraints.

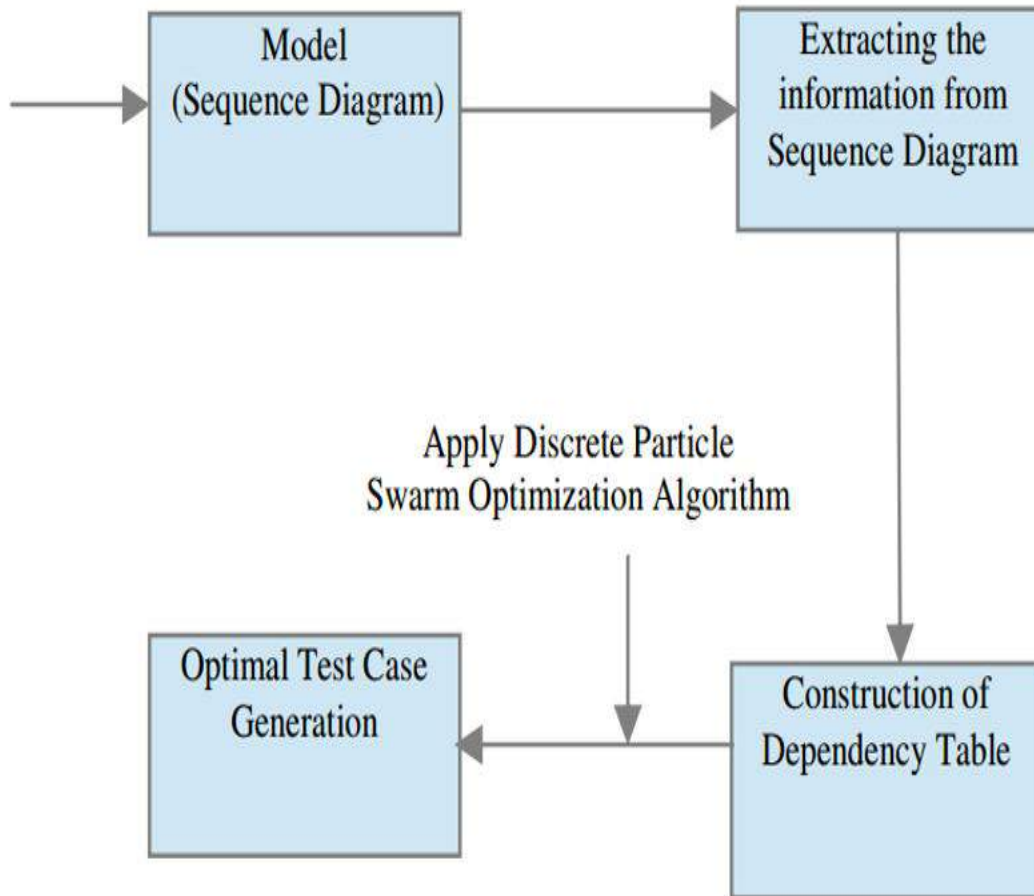


Fig 1.1: Diagram of System Model

1) **Proposed PSO based Clustering:** Particle Swarm Optimization is method that optimize problem iteratively from set of solutions. Kennedy and Eberhart proposed this algorithm in 1995 and was inspired from nature i.e., Bird Flocking Behavior. PSO is mimicked from natural environment so it is considered as artificial intelligence field.

Initially each particle i.e., is randomly assign position and velocity. In each iteration velocity and position of particle is updated from current velocity of particle and previously local best and global best position. New position of particle can be updated from calculated new velocity. Each particles velocity is substantially influenced by its new best position. At the end these algorithm will meet optimized position.

Let's consider a scenario in which group of birds are searching food in local space and there is only food piece is available in local space and no bird knows it. But these birds know how far the food piece is located in the iteration. There are various set of paths available to reach to the food piece but these birds selects the optimal path from the available set of paths.

By comparing the above scenario with our clustered network, initialize the particle and its position and velocity. During each iteration Particle uses fitness value and pbest value to meet best pbest i.e., gbest to maximize the optimal solution from the set of solution available. When fitness is better than local or pbest then replace pbest and update the solution iteratively

1.1 PSO Algorithm:

1. for each particle do
2. Initialize particle
3. end for
4. while true
5. Calculate Fitness function
6. Calculate pbest
7. if fitness better than pbest then
8. pbest = current fitness
9. else previous fitness = pbest
10. set gbest =best pbest
11. for particle value do
12. update velocity and position
13. end for
14. end while

1.2 Flowchart:

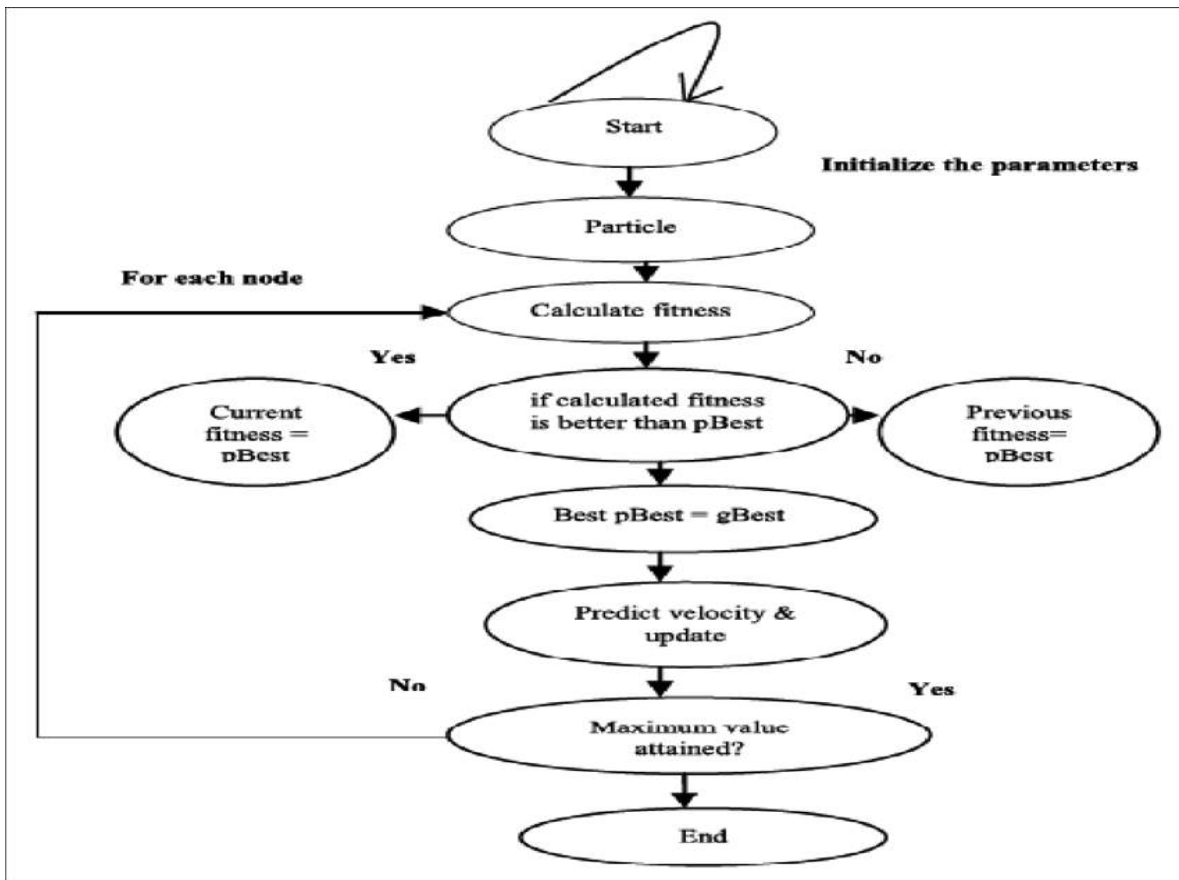


Fig: 1.2 – Flowchart of PSO Algorithm

Terminating condition of iteration:

- Iteration = max iteration
- Solution = optimal solution
- New result = previous result

1.3 Advantages of PSO:

- PSO is associated with machine learning approach and can be applied to both scientific research and Engineering use.
- Only the most optimal solution is obtained from set of solutions.
- this is very efficient global search algorithm
- simple to implement

1.4 Formulation of Particle Swarm Optimization algorithm:

$$V_{id}(t) = w \times v_{id}(t-1) + c_1 \phi (P_{id} - x_{id}(t-1)) + c_2 \phi_2 (P_{gd} - x_{id}(t-1))$$

$$X_{id}(t) = x_{id}(t-1) + v_{id}(t)$$

Table consists of list of variables and its description:

v	The Particle velocity
x	The Particle position
t	Time
c ₁ ,c ₂	Learning Factor
ϕ ₁ ,ϕ ₂	Random number between 0 and 1
P _{id}	Particle s best position
P _{gd}	Global best position
w	Inertia Weight

1.5 Applications of PSO Algorithm:

- Function Optimization
- ANN(Artificial Neural Network)

C. CONCLUSION

The performance of previous proposed work is enhanced by PSO based Clustering. The sensed data from sensor nodes are aggregated by the Cluster Head and send to base station. The Cluster Head selected in particle Swarm optimization in distributed way .PSO based algorithm delivers more data to the base station compare to leach and also it reduces the overload of the Cluster Head selection of the Particular Cluster. With these PSO algorithm all the drawbacks and shortcomings of the various existing algorithms discussed in this paper can be minimized. Thus the PSO algorithm guarantees minimization in energy consumption of the sensor node and also the energy consumption in selecting the Cluster Heads which results in extending the life time of the Sensor nodes and the Cluster Head node. Also it reduces the conflicts which is caused during Cluster Head selection in various Clusters.

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