Energy Consumption Techniques for Wireless Sensor Networks Using PSO and TSA Algorithm

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Abstract**—** *Optimizing energy consumption is the main concern for designing and planning the operation of the Wireless Sensor Networks (WSNs). Clustering technique is one of the methods utilized to extend lifetime of the network and balancing energy consumption among sensor nodes of the network. In this paper, we propose the recently developed, heuristic optimization algorithms like Particle Swarm Optimization (PSO) and Tabu Search Algorithm(TSA) as well as the traditional Fuzzy C-Means (FCM) clustering algorithms. A comparison is made with the well known cluster-based protocol approach developed for WSNs known as harmony search algorithm which is music based Meta heuristic optimization method. Simulation results demonstrate that the proposed protocol using hybrid can reduce energy consumption and improve the network lifetime.*

Keywords**— PSO, Clustering, TSA, FCM.**

I. INTRODUCTION

In Recent developments, wireless network plays a vital role in making advance technologies in science and social welfares. Micro-electronics has created immense level of producing cheap state of network implementation in wireless technology. Advancement in the field of science has created strong base in developments of various applications such as weapons technology, life saving medical trends, agricultural fields, monitoring/predicting systems in industrial applications and process control systems. Each sensor nodes used to sense the environmental changes of the network implementation and to calculate the processed data and to communicate with the global system. It also calculates the energy levels of various networks which is an important factor to be watched out while analyzing life time of the system.

Clustering is a standard process for implementing energy efficient networks and to improvise its system performance in WSN. Each sensor nodes are grouped by various clusters based on its energy level; these clusters are processed under a cluster head detection which can process data parameters locally before being sent to a base station. LEACH and HEED network protocols provide solutions to cluster head election and to reduce energy dissipation. Testline Timing for Cluster formation Algorithm [TTCA] improves the processing time required to connect various cluster nodes both locally and globally and to maximize the network lifetime by election of proper cluster heads. It is time based chain topology which improves the performance still better compared to other network topologies.

II. CLASSIFICATION OF ALGORITHM

Clustering algorithms have created immense research oriented approaches to cover its all processes. LEACH is proposed which is the benchmark for all other processes created at later stages and provides single hop self organized clustering algorithm for wireless sensor networks. Many started developing various stages in clustering networks based on the sensing techniques, communication levels and network lifetime. It improves the transmitting range and reduces the number of nodes that communicate with the base station. It creates nodal interaction between clusters and the sink.

Energy Efficient Coverage Control Algorithm (ECCA) was proposed which is based on multi –objective genetic algorithm for full coverage of network system with improvement in lifetime. Particle Swarm Optimization [PSO is an evolution based algorithm which maintains information regarding position and velocity of each nodal structure formation.

In this paper, PSO-TS algorithm is carried out in the efficient way to improve the energy levels and to communicate the powerful link between the sensor nodes (end to end communication) with multiple constraints. It provides the basic solution for the development of improved lifetime and implements strong bondage between the structural link nodes.

In state network coverage, clustering process is carried out in sensor networks with the following assumptions:

1. All nodes remains stationary and present in the Network area are initially charged with some base energy.
2. Multi-hop situation is allowed for better communication link.
3. Nodes can be arranged randomly in the two dimensional space.
4. Constraints required for the base station from the nodes are neglected when the base station is located away from the network area.
5. GPS devices which are used to sense the network nodes are neglected.
6. Noise interference, signal fading and other losses are neglected during communication linkage.

The distance between the 'n' sensor nodes from the base station from the point P (x_i, y_i).

$$d(i, j) = (x_i - x_n)^2 + (y_i - y_n)^2 \quad [1]$$

III. PROPOSED WORK

In PSO-TS hybrid system, cluster routing is an optimal path to find the minimal cost of node selection between various clusters. If the energy present in each node is greater than the optimal energy, transmission between the nodes and communication channels are ready for sensing. The time required to analyze the structural formation of nodal networks plays a significant role in determination of time constraints. Duty cycle determines system based time constraint analysis where T_1 is the state of nodes to be active and T_2 is the state of nodes in sleep mode.

$$\textbf{Duty cycle } (\alpha) = T_1 / [T_1 + T_2] \quad [2]$$

Generation of network formation using ACO, GA, SA provides some clustering defects during analysis. This has made researchers to concentrate more in this area and to develop better solution. PSO-TS have overcome this structural defect in cluster formation with better accuracy. Nodal communication is better in test line timing approach because it provides link between the data nodes globally and locally. The intensity of pheromone and the path distance are the important factors to be considered during Ant network analysis. Ants analyze the shortest path based on the intensity of pheromone deposited in different paths.

Population based heuristic optimization algorithm which is based on food searching by birds and fish is used in Particle swarm. The population analysis is important part of network formation. Particle swarm presents an improved computation time and better cluster structure for system analysis from directional or distance based techniques.

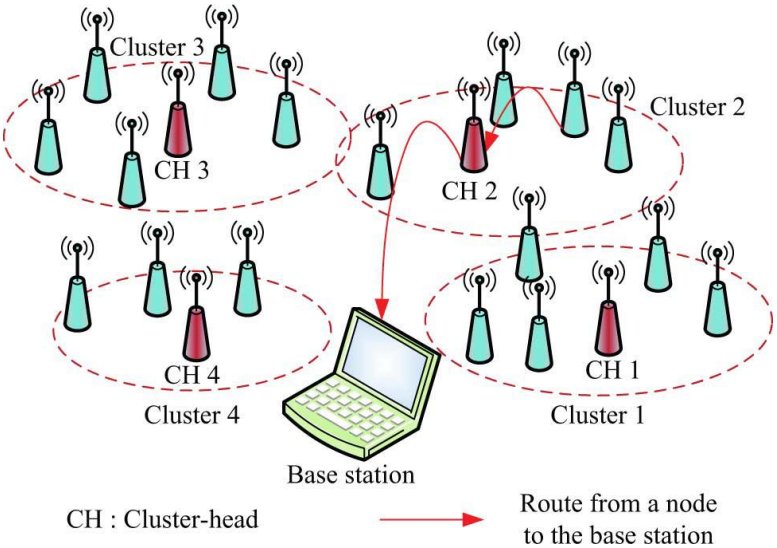

FIG 1: Structure of Clustered WSN

In PSO-TS hybrid system, many sources of system need to be analyzed and performed in each and every point of time. Energy levels are not same during each analysis of node formation. There may be collision during each process during that time energy levels may increase or decrease at certain point of time. These energy levels determine the next corresponding position of the nodal system. Cluster head detection of various sensor nodes is shown in figure.2. Network lifetime depends on the energy level consumed for each channels and the transmission between the nodes.

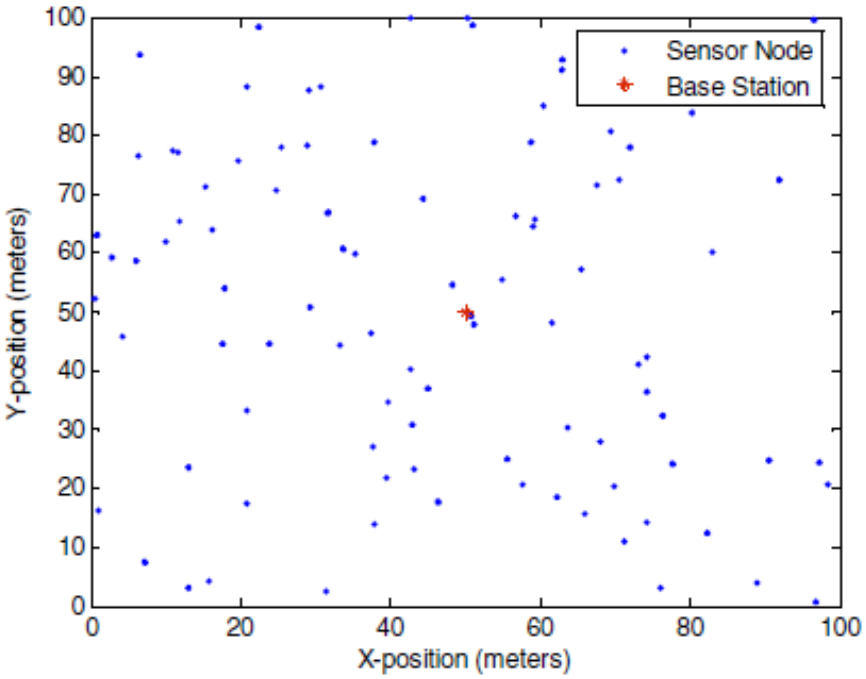

FIG 1: Cluster Head Detection from the Various Nodes

The goal is to find an appropriate initial solution for the problem, in order to get the best solution from tabu search iterations within a reasonable delay. The algorithm depicted in Fig. 1 is proposed. It starts sorting active nodes according to their degree in graph G^r decreasingly. For each iteration, the first active node i, not yet covered by the initial solution F_o, is selected. The algorithm determines the largest size clique that contains the selected active node i with adjacent nodes in graph G^r, which have yet to be covered by F_o. This clique is considered a new cluster and node i becomes the cluster head.

Algorithm does not ensure that all non active nodes are assigned to a cluster. Consequently, if node i is not covered by any cluster when the algorithm ends, it is assigned to a cluster whose head is adjacent to node i. However, this leads to the fact that an initial solution could not be feasible, i.e., a node made up of at least one cluster does not consist of a clique in the graph. A penalty equation to evaluate a solution is proposed in the following sections.

The definition of the neighbourhood Node of a solution s is a crucial step as it determines the final quality of the solution and has a direct impact on the execution time. Two types of moves are distinguished: the first move involves an ordinary node, i.e., a non active node, and the second move involves an active node. This is due to the fact that an active node could be a cluster head and thus build a new cluster. Furthermore, the third move that involves a cluster head and allows removing an existing cluster from a solution is also considered.

1. A Move Involving a Regular Node.
2. A Move Involving an Active Node.
    a. Reassigning node to a cluster whose head is adjacent to a.
    b. Select node to become the head of the cluster to which it is assigned.
3. A Move Involving a Cluster Head.

IV. SIMULATION RESULTS AND DISCUSSION

We evaluate the performance metrics for the Timeline approach for cluster formation using hybrid techniques compared with the earlier techniques. It gives enough opportunity to learn the basic techniques used in various clustering approaches. The simulation model was performed using MATLAB. We carried out basic methodology developed in LEACH for better system analysis. Our analysis focus on Generation of energy efficient cluster with respect to time and determination of network lifetime.

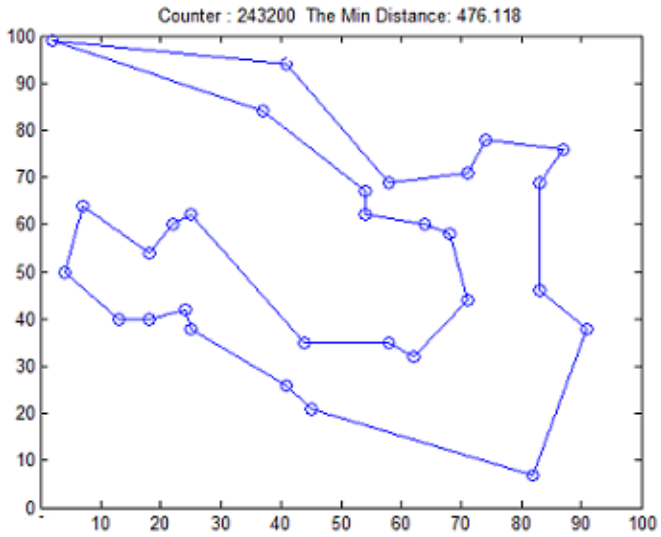

FIG:3 Simulation Result of TSA

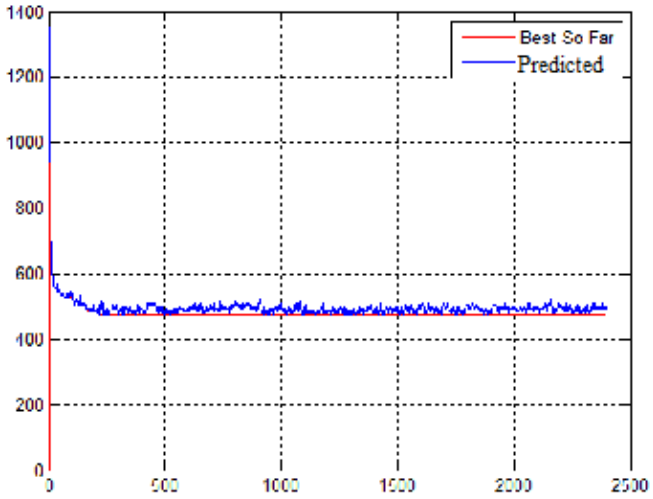

FIG 4. Simulation Result of PSO-TS

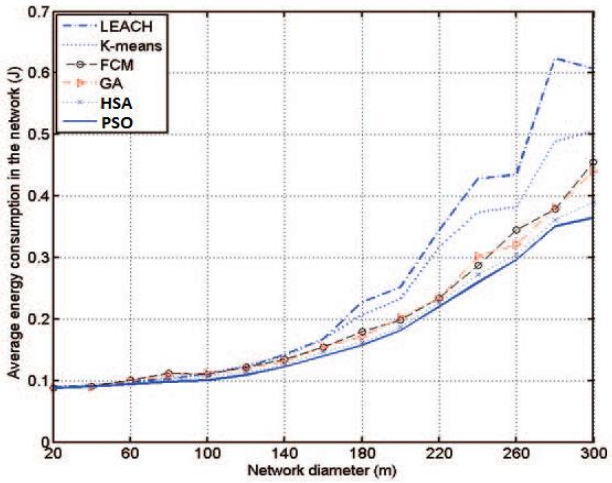

FIG 5.Comparison of Various Results

In this paper we carried out simulation for PSO-TS and compared with the earlier results of other papers. The data communications between the nodes are stronger due to better structural analysis of nodes both globally and locally. After 150 iterations, we got better results compared to LEACH and HAS algorithm. The Efficiency is improved in PSO-TS by 6 -10% more than HSA algorithm. This indicates that hybrid PSO is more stable than other optimization techniques and provides better convergence property.

V. CONCLUSION

From the analysis and simulation results, we can conclude that Hybrid optimization [PSO-TS] Algorithm used for network implementation simplifies the structural analysis between the nodes and to minimize the total energy costs which indeed extend the network lifetime considerably. PSO-TS provide higher reliability compared to other algorithms. Future works can be carried out in this field of other optimization processes such as PSO-GA, PSO-HAS.

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