# Improving Performance of Large-Scale Wireless Sensor Networks through Better Cluster Head Management and Localization

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***Abstract – The advancement of wireless connectivity has facilitated the growth of a sensing-inclusive infrastructure; a computing and communication dimension that creates managers adjusted to Base Station experience and respond to a phenomenon in a particular setting. Such an infrastructure's portion involves hundreds or even thousands of lightweight, low-cost, multifunctional sensors that can feel computing and communicate via short-range transceivers known as sensor nodes. Such sensor nodes interconnect to turn into a Wireless Sensor Network. Wireless Sensor Network is now a good option for numerous applications because it has low cost, fast installation, ad-hoc, and multi-functional framework. Wireless Sensor Network's field area ranges from ecosystem monitoring to applications in hospitals, military service, shipping, surveillance systems, weather analysis, real-time tracking, fire detection, etc. Wireless Sensor Network may contend as a wireless network by providing an exception for its service areas. Throughout the actual world, though, such networks are comprised of tiny nodes that are run utilizing a battery that has some memory limits, processing capacities, bandwidth, and corresponding equipment throughout resource-constrained wireless sensor networks.***

***Keywords: Wireless Sensor Network, Improving Performance, Efficiency of Large-Scale Wireless Sensor Network***

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## INTRODUCTION

Wireless sensor networks have evolved as an increasingly respected and emerging medium for wireless networking and expanded application areas. Wireless sensor network expertise includes broad scope fields such as environmental protection, defense equipment, and detection, ecosystem evaluation, agricultural goods processing, home electronics, travel, medical applications, general applications. Wireless sensors are compact, interconnected instruments that combine transmitter and receiver with low energy sources. Basic features of a wireless sensor node coordinate for computational purposes information, resources, and an economical processor. The primary objective of every wireless sensor network is to attain the function of a dispersed sector. It can be achieved by integrating different sensor nodes with specific operations close to sensing, processing, distributing, and storage.

Models of confidence and integrity are considered one of the routes to follow reliability in a wireless sensor network for the provided question. Despite this work on concepts of confidence and legitimacy, substantial traction has been growing over the last few years. Throughout the past, numerous confidences & credibility models have been proposed, primarily based on data aggregation, collection of cluster heads, unified trust management, and stable routing. Nonetheless, some issues such as scalability, computability, collaboration, accessibility, and routing protocols within the wireless sensor network need to be established. Many trust testing contexts belong to an algorithm-based method that decides the entire output of nodes in terms of resource accessibility, accuracy, and energy consumption.

## REVIEW OF LITERATURE

**Ahadipour et al. (2017)** suggested a novel probabilistic key pre-distribution system for Large Scale Wireless Sensor Network that used position knowledge to dramatically boost the efficiency of random key pre-distribution. The network was divided into several regions to connect the position details of the nodes in the key allocation method, and graph coloring strategies were used to efficiently distribute the random key. The proposed scheme has better scalability by endorsing more node numbers and thus that the chance of a mutual exclusive key between the neighboring nodes, i.e. the possibility of getting an independent node was slightly lower relative to the current random key pre-distribution schemes. Such terms were checked in the simulation results.[1]

**Rosset et. al., (2017)** introduced a groundbreaking bio-inspired routing mechanism, known as CB-RACO, which included the meta-heuristic ACO with the computational cost cheap and dispersed group detection technique CB-RACO demands low memory and overhead in routing route creation and maintenance. CB-RACO gained unprecedented flexibility in data processing through a data retransmission approach focused on group acknowledgments. For broad scenarios, CB-RACO was repeated according to the parameters of goodput, distribution pause, and energy usage. The findings suggested that the proposed approach might substantially boost association with ant-based techniques that do not trust group structures.[2]

**Hu et. al., (2017)** proposed a distributed search algorithm for estimated similarities to retrieve identical, high-dimensional sensed data for a wireless sensor network application. The sensors were initially broken into several clusters utilizing the hierarchical clustering methodology. The sink also moves the compressed hash code collection to the cluster head. Finally, to clean up unnecessary sensed results, the approximate similarity score was connected to a defined threshold. Therefore, the higher accuracy of the quest and energy conservation may be accomplished. Extensive simulation results showed that the suggested algorithms produced substantial precision and energy efficiency output improvements compared with current algorithms.[3]

**Amri et. al. (2017)** proposed a fuzzy positioning algorithm utilizing a wireless channel flow metric to evaluate the distance between the anchor and the sensor nodes. The proposed work was subsequently focused on the centroid algorithm, which calculates the location of anonymous nodes with the fuzzy Mamdani and Sugeno inference method to increase the precision of the approximate locations. Once nodes have been found by the localization algorithm from an undisclosed role, the suggested method effectively chooses the next-elected cluster head to decrease the dissipation of sensor nodes by electricity. The results of the acquired simulation showed that the suggested system outperforms current energy usage, execution period and position error approaches, including the number of packets transmitted to the base station.[4]

**Neamatollahi et. al., (2016)** proposed a clustering method that selects nodes with the most residual energy as candidate cluster head in a respective area, in which the strongest nodes are selected as the final cluster head. In comparison, this clustering algorithm used fuzzy logic to alter the cluster radius of cluster head nodes to mitigate the hot spot issue; this was based on some local knowledge, along with the distance to the BS and local density. Results of the simulation revealed that by minimizing the hot spot issue, the proposed solution achieved improvement concerning both the lifetime of the network and power conservation.[5]

## RESEARCH METHODOLOGY

Here, two methods are proposed, one for Cluster Head Selection and Cluster Formation and another for Position Aware Routing.

### Proposed Methodology for Algorithm I:

The proposed method for Cluster Head Selection uses k-means Clustering for Cluster formation, Particle Swarm Optimization-Dynamic Data Exchange for Cluster Head Selection and Dynamic Source Routing protocol for communication. Within the suggested technique, the nodes are initialized. A cluster centered on k-means is rendered with participants. A cluster head must be cautiously picked from among the cluster leaders. This is achieved using methods from particle swarm optimization-dynamic data exchange. Cluster head selection is rendered by having parameters such as Node Energy, Neighbor distance, and Node Coverage. A right and shortest route are evaluated through the Dynamic source routing protocol, and it also facilitates the efficient preservation of contact between nodes. If the cluster head is to be located within the base station scope, then the packets are transferred to the intercluster and the cluster members accumulate the results. The packets are sent to the intercluster in the case of a cluster head located out of base station scope. The correspondence with cluster head is previously done by dynamic source routing. Aggregation of data only happens while the cluster head isn't gone. Recently the cluster is created when the cluster head is dead. The protocol is repeated in a large-scale network for efficient and fast communication involving clusters. [6] Figure 1.1 lays out a flowchart of the suggested approach:

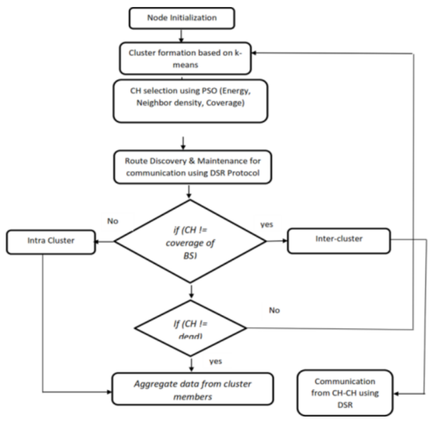


**Figure 1.1: Flowchart of the Proposed Cluster Head Selection Algorithm based on Particle Swarm Optimization**

**Proposed Methodology for Algorithm II:**

Another proposed method suggests a position-aware routing method with the least overheads to improve the efficiency of the large-scale wireless sensor network. Figure 1.2 displays the flowchart for the suggested technique. It consists mainly of stages such as Large-Scale Wireless Sensor Network Creation, Sensor Node Identification, Position Identification, Range of Distribution, Coverage Node Detection, Position Estimate Localization Routing Method, Sink, And Efficiency Metrics described in the next part.

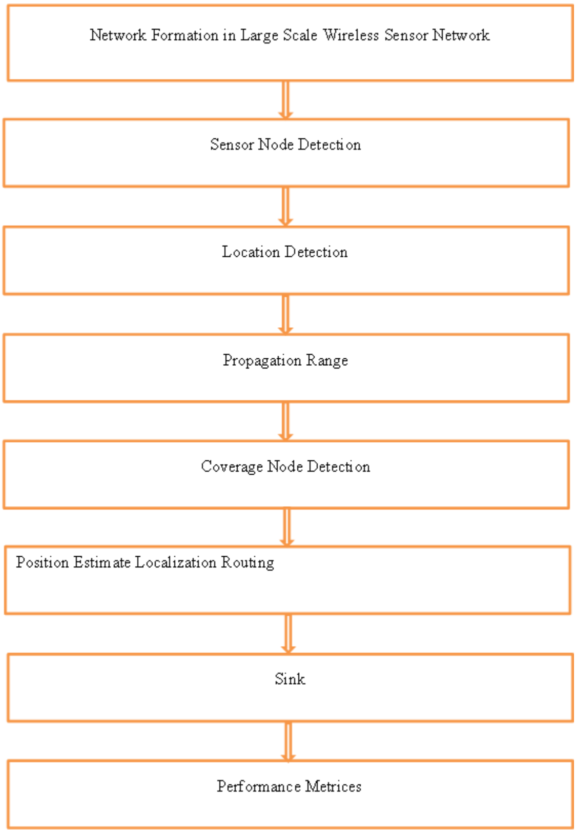


**Figure 1.2: Flowchart of the Proposed Position Aware Routing Methodology**

## RESULT AND DISCUSSION

Both of the proposed methods are verified using the NS2 simulator. Simulation scenarios are generated in NS2 in three steps: the main stage is to explore its simulation goals, network setup, expectations of specific output parameters, and kind of predictable effects. The next stage includes designing and configuring the components of the network, beginning and running the events until the period defined in the simulation script for Tcl. The third stage includes checking the output of the network under simulation, i.e. examining the trace data. Generally, the simulator is defined by a TCL class Simulation, which represents the number of protocols required to set up a simulation and choose the type of event scheduler needed to execute the simulation. We build an instance of the class Simulation at the beginning of the TCL simulation script and then invoke various methods to construct nodes, network topologies, and set up other parameter values. The Simulator instance is generated using the "current simulator" instruction, which returns the Simulator handle and is stored in variable ns.

**Proposed Algorithm I: Cluster Head Selection using Particle Swarm Optimization based on Distance, Density and Energy**

**Table 1.1. Simulation Parameters**

| PARAMETER | VALUE |
|---|---|
| Number of Nodes | 73 |
| Packet Size | 50 |
| Routing Protocol | DSR |
| Simulation Time | 40s |
| The Dimension of Topography (x,y) | 1186, 600 |
| Interface Queue Type | Drop Tail / PriQueue |
| Antenna Type | Omni Antenna |
| Application Layer Protocol | Constant Bit Rate (CBR) |
| Connection Establishment | UDP |
| Channel | Channel / Wireless Channel |
| Radio Propagation Model | Propagation / Two Ray Ground |
| Coverage Range | 500 Meter |
| Node Density | 73 |
| Cluster | K-means |
| Route Optimization | PSO |
| Topology | Grid Topology |

The efficiency of the proposed method is measured using the following performance indicators and compared with the existing Dynamic Source Routing (DSR):

1) Throughput (kbps)

2) Energy (J)

3) End-End Delay (ms)

**Performance Results**

The simulation data derived from either the experiment is given in Table 1.2. The efficiency of the current DSR Method and suggested Cluster Head Selection and Routing scheme is studied at different network sizes such as 20, 50, and 75 nodes. It is established from Table 1.2 that the DSR system provides 565kbps, whereas the PSO-DDE adopted a purposive 75 nodes for 690kbps of PDR in network bandwidth. The DSR scheme could reach the destination only after 35ms in 20 node setting, but in the case of PSO-DDE strategy, this could hit the target within 31ms. DSR cannot hit the destination in 75th nodes after 99ms, but the proposed method could meet the target within 97ms.

**Table 1.2 Performance Results' Analysis**

| | DSR (Existing) | | | Proposed Method | | |
|---|---|---|---|---|---|---|
| No. of Nodes | 20 | 50 | 75 | 20 | 50 | 75 |
| Throughput (kbps) | 210 | 300 | 565 | 220 | 390 | 690 |
| Energy (J) | 0 | 25 | 48 | 0 | 23 | 39 |
| End-To-End Delay (ms) | 35 | 64 | 99 | 31 | 62.5 | 97 |

**Proposed Algorithm II: Position Aware Routing Algorithm:** Regarding the proposed research the simulation parameters considered are as follows:

**Table 1.3: Simulation Parameters**

| Parameter | Values |
|---|---|
| **Channel** | Wireless channel |
| **MAC type** | 802.11 |
| **Propagation model** | Two Ray Ground |
| **Number of nodes** | 250 |
| **Routing Protocol** | DSDV |
| **Topography Range** | 984, 995 |
| **Antenna** | Omnidirectional |
| **Network Domain** | Large-Scale Wireless Sensor Network |
| **Simulation Time** | 50s |

The efficiency of the proposed method is measured using the following performance indicators and compared with the existing CLA (Centroid Localization Algorithm) method.

1) Average Position Error (percentage)

2) Energy Consumption (percent)

3) Communication Cost

**Performance Results:**

The confirmation of the findings is listed in Table 1.4 below. This also contains details regarding the outcomes derived from the application of the current methodology and the planned techniques. In this analysis, three parameters are listed, namely Average Position Error, Energy Consumption, and Communication Cost

**Table 1.4 Performance Results' Analysis**

| Parameter | Centroid Localization Algorithm (Existing) | Proposed Method |
|---|---|---|
| **Average Position Error (%)** | 42 | 30.5 |
| **Energy Consumption (%)** | 24 | 18 |
| **Communication Cost** | 10.08 | 9.53 |

The average ranking error of the current Centroid Localization Algorithm is 42 percent while the new Position Estimate Localization Routing algorithm's average location error is 30.5 percent which is less than the actual Centroid Localization Algorithm. The Centroid Localization Algorithm's energy usage is 24 percent and is reported as low as 18 percent for the suggested algorithm. The energy usage of the new strategy is lower compared with the current algorithm. The exiting technique's communication cost is 10.08, although it is measured as 9.53 for the suggested algorithm which is an improvement.

## CONCLUSION

This paper has proposed Cluster Head Selection using the Particle Swarm Optimization algorithm, which considered three parameters for the best collection of CH candidates, such as intra-cluster size, neighbor density, and residual energy. The existing Dynamic Source Routing (DSR) performance figures have been compared to the proposed methods' results in terms of Throughput, Energy, and End-to-End Delay. The proposed method's test results indicated dominance over the existing method.

Another method for Position Aware Routing for Large Scale Wireless Sensor Networks has been also proposed in this paper. It reduced energy usage, the time of operation in addition to the overhead contact. Because of the trade-off between position accuracy and time expense, overall device efficiency for large-scale wireless sensor networks has been improved. Simulation tests revealed that the proposed method had increased efficiency compared with an established framework based on Centroid Localization Algorithm.

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