Fusion protocol for improving coverage and connectivity WSNs

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Abstract
The authors proposed a fusion protocol using multilevel clustering (FPMC), which is completely dependent on the increased coverage and wireless sensor network (WSN) reliability-clustering framework to eliminate duplication. Therefore, a static sensor for a point of interest is allocated where possible so that the particular area can be protected. Furthermore, FPMC ensures that only one sensor node is allocated to cover a specific point of interest. The network coverage, energy usage, mean movement of WSNs nodes and sensor nodes are active in each loop due to which efficiency of the proposed protocol was assessed under various densities, and its performance was also analysed. Evaluations have shown that with restricted active nodes and sensor nodes, the FPMC can increase the networking coverage. The FPMC should be stressed as reducing the overlap level. The proposed protocol is based on the fusion protocol using multi-level clustering for improving coverage and connectivity WSNs.

1 | INTRODUCTION

Target monitoring and wireless sensor network (WSN) including environmental surveillance [1, 2] have been currently used in the network security. Target coverage and accessibility are two significant problems of WSNs. The objective coverage is aimed at covering a particular collection of points of interest in the WSN deployment area. It determines the efficiency of the network's monitoring [3]. Connectivity is required to collect data and report sink node data from a WSN sensor. Sensor mobility has been exploited to expand coverage and accessibility of random WSN's by the relocation of some mobile sensors to new positions to boost the network's monitoring [3]. Connectivity and accessibility are two significant problems of WSNs. The objective coverage is aimed at covering a particular collection of points of interest in the WSN deployment area.

Here, the authors discuss an almost essential issue that minimises the movement of sensors, both for target coverage and network communication. When battery-limited power drives the sensor and ultimately significantly decreases power usage in mobile sensor networks, the highest consideration should be given to energy consumption. Sensor traffic will, in turn, be limited to extended network life as sensor traffic absorbs even more resources than sensing and connectivity. But the majority of studies currently available were aimed at enhancing objective coverage efficiency, e.g., identifying objectives with a high likelihood of identification, reducing false alarm, and detecting time. Minimising sensor activity has earned little attention. In order to fill this void, this study focuses on moving sensors for specific purposes and establishing a connected grid with minimum movement and electrical consumption. In this regard, the authors develop a problem to deploy sensors for the WSNs, so that target and network communication will have limited movement. The issue of the WSNs has thus been split into two sub-sets: The coverage target (TCOV) and the Network Connectivity network. When integrating the solutions to the two sub problems, the WSN problem is solved efficiently. The authors summarises significant contributions as follows:

1. First, the authors illustrate the NP-hardness problems of WSN coverage and connectivity. After that, an exact algorithm based on the extended fusion protocol using multi-level clustering (FPMC) is proposed in the particular case of WSNs that disperse the target by over twice the coverage radius from one another to the next to find the optimal solution for WSN coverage and connectivity.

2. Two heuristic algorithms were proposed for the general case of WSNs coverage and connectivity: the partition-based algorithm, and the multi-level clustering of destinations fusion protocol, respectively. By reducing the number of sensors moved, the simple algorithm decreases the total movement size. The WSN coverage and communication algorithm minimises the entire distance of the movement by...
grouping and sending sensors to the objectives of the multi-level clustering fusion protocol.

3. Also, a detailed simulation analysis is performed to determine the efficacy of algorithm proposed. Outcomes showed that by adding the diagram solution in correspondence to Voronoi’s multi-level clustering, the original WSN coverage protocol and communication solutions give a promising solution tot issue of balance the load of various. The rest of the research paper is structured accordingly. Problem Statement is in Section 2 and the reviews on research and coverage and compatibility on WSNs are in Section 3. The solutions, the problem, and the multi-level clustering problems for the WSN coverage and connectivity are given for Sections 4 and 5, respectively. The proposed methodology for coverage and connectivity is presented in Section 5.1 Discovery coverage models. Theoretical review of the output of the solutions suggested approximation coverage models in Section 5.3, Section 5.4 discusses connectivity analysis, Section 5.5 discusses mixed sensing coverage and network connectivity and Section 6 consists of the conclusion and future scope.

2 | PROBLEM STATEMENT

Here, the authors focus on maintaining communication in each area between all active sensors. A more realistic deployment approach demands that all sensors be cycled to conserve energy for those densely deployed WSNs [3]. Duty cycling will activate or disable sensors following a particular scheduling protocol so that all sensors areas deplete their energy slowly and uniformly as far as possible, and thus guaranteeing field coverage in each planning round (or only round). In particular, the following questions are addressed:

1. Why is the active sensor spatial density condition sufficient to cover the entire area?
2. when ensuring connections between all sensors while retaining a sector’s WSN coverage and access, which must be the lowest contact ratio to the sensor range?
3. Why do we construct duty cycling protocols in an environment with limited active sensors that are continuously linked in every round to each other to provide visibility and connectivity to the WSNs?

Table 1 shows comparison of different cluster head selection techniques concerning their assistance in the collection of cluster heads, the criteria used, the required clustering, the cluster composition and the uniform or equal distribution of the cluster heads (DCH).

3 | RELATED WORK

In literature, a variety of WSN coverage and communication configuration protocols was suggested to extend the network life. Within this segment, a selection of these setup protocols is analysed and summarised. In [22], the problem was discussed in order of sensors needed for the target region entirely. The sensor density depends on the sensor’s physical properties, and the goal characteristics were proposed as an exposure-dependent model [23]. The majority of the literature on coverage analysis and networking suggests that the sensors are installed explicitly in the FoI. Here, the study of the number of an algorithm used for WSN coverage and communication is discussed from the literature. However, the research of authors was the first to allow the standard usage of sensors beyond the FoI border on a random basis. Ref. [24] addresses the open problems related to the design of practical coverage protocols (and propose potential solutions to solve them). Ref. [25] reflects on the computational route for various heterogeneous WSN scenarios. A series of clustering approaches are widely covered in the heterogeneous WSN scenarios for routing decisions. The proposed algorithm reduces movement dependence on mobile nodes and can extend the coverage life and improve network coverage effectively with minimum active nodes [26].

3.1 Basic concept of connectivity and coverage in WSNs

The primary joint connectivity and coverage analysis [6] showed that if radius is double of the sensor broadcast phase, an associate with WSN, given that sensor coverage is guaranteed. The authors of [7] suggested k-covered WSN connectivity steps. Ref. [8] proposed a WSN-based directional sensory approach where the directional sensor coverage area would depend on its location and orientation. [The authors of [9] and

| Scheme | Method | Base algorithm | Review |
|--------|--------|----------------|--------|
| Weight-Based Unequal Clustering Routing Protocol (WBUCRP) | Nurhayati et al. [38] | Unequal Clustering Routing (UCR) | WBUCR enhances the network lifetime at steady rate |
| Energy-Coverage Ratio Clustering Protocol (E-CRCP) | Zeng et al. [40] | Low-energy adaptive clustering hierarchy (LEACH) | It significantly reduces the number of relays used for data transmission |
| Generic Algorithm Based Energy Efficient Clustering Hierarchy (GAECH) | Baranidharan et al. [50] | Gateway Classification Algorithm (GCA) | GAECH algorithm’s efficiency is better than EAERP, LEACH, and GCA |
| LEACH-imp | Hu et al. [38] | LEACH | LEACH-imp algorithm works better than LEACH algorithm because every node divided into fixed clusters |
| GAF algorithm of Aligned Grid (GAFDG) | Zu-jie et al. [39] | GCA | GAFDG algorithm |
proposed algorithms of mobile WSNs for adaptive, distributed, and asynchronous coverage. Ref [11] proposed the heterogeneous WSN differential coverage algorithm, where the network areas can vary in sensor coverage level. As regards to the number of sensor numbers, a k-related problem was defined as a polynomial-time algorithm. In the case of heterogeneous planar WSNs, the coverage problem was proposed by Lazos and [13] to measure the coverage obtained through the stochastic. The proposed efficient distributed algorithms [14] suggested an optimised polynomial-time worse than the average algorithm based on the Voronoi matrix and graph search algorithms used for solving the problem of energy consumption as well as coverage. Many critical features for randomly used WSNs have been studied in the three-dimensional range of data transmission for compatibility and protection. If the transmitting distance is at least twice the sensing distance in the transmission range, the active node networks would be connected as the network created with these nodes is secured and will cover the same area as all the defined nodes initially. Detailed research on scope and communication problems on WSNs is provided in [13].

4 | FUSION PROTOCOL USING MULTI-LEVEL CLUSTERING

In cluster-based literature, fusion strategies are proposed that would approach innovatively to offer new ideas to reduce energy consumption. The collection heads closer to the short distance between the base station than those located further from the base station, it saves energy for transmitting the data between clusters and [13] choosing the best node as the cluster head with the FPMC algorithm. Gradual cluster head election algorithm slowly determines the cluster and heads with respect to the closeness of the neighbour node and the residue amount of energy, and the neighbour’s one-hop knowledge chooses cluster heads based on four factors that influence network lifetime.

We used four-phase for improving the life of data transmission node

Phase 1: First, the node range is defined from cluster centroid: the BS computes the distance between the cluster centroid, \( r \), and a node

Phase 2: The remaining battery power is computed: if the battery power is high, then the risk is also high in CH node.

Phase 3: Mobility: The behaviour of the network is significantly determined by node stability. The high mobility of the node leading to the rapid re-selection of CHs can often distress the topology setup.

Phase 4: To avoid disconnecting of a network, the weakness possessed by each node is determined from which the use of those nodes can be limited. This is removed, and the whole network is disconnected. This element, therefore, informs us of the weakness of a node. The node will not be used as a CH because it is large for a given node. The following procedure will help us to calculate this factor:

Step 1: The first step is to level the non-planer graph for transformation. There are some solutions already available in the literature, such as the reduction in cross-connection weights.

Step 2: The diagram describes cycles (loops). Remove a logical node for every loop. Define the logic node as two if they have a similar edge.

Step 3: Repeat step 2 to free cycle (loop) graph. Using the step 2 iteration call, call the graph as level \((n-1)\).

Phase 4: Then every node’s vulnerability factor is calculated by using the following formula:

\[
VF = \frac{Node^2}{Node^2} \times Level^2 + 1/Level^2 + 1 \tag{1}
\]

where

- \(Node^2\) to remove the number of the nodes on the condition of \(i^b\)
- \(Node^2\) remove the \(i^b\) node
- \(Level^2 + 1\) remove the \(i^b\)

The number of rates following the deletion of the I node is afterward. The more fragile it is, the node with as throng IV value intuitively. Such a node’s failure results in the disconnection of entire network. Therefore, it can be inferred from the above definition that it is possible to prevent these nodes from being CHs that d have greater vulnerability values (IV).

5 | THE PROPOSED METHODOLOGY FOR CONNECTIVITY

For the study of wireless sensor network (WSNs), multiple percolation-based approaches were proposed. Initially, the principle of continuous filtration was concentrated on identifying the cryptic density of a Poisson point procedure, which would almost certainly allow a connected unrestricted component to communicate with a multi-hop long distance. Gilbert concluded that the filling factor would be available for random aircraft networks, an integral feature of the number of points in the R circle. The original model has since been used to research the wireless percolation spectrum. They are leading to a connected element without boundaries. The participants also addressed the practically assured presence of an infinite connected portion based on the connective range between the necessary stations and the customer communication range.

The existence of site percolation and bonding in Poisson and stationary hard-core processes has been shown. The crucial limits for the presence of an open site path and an available connections path were calculated with simulation. The concept of monotonous percolation is proposed based on local node transmission radius changes for effective network topology regulation. The algorithms give a guarantee that the paths between any source and target node pairs are relatively short, which enables monotonous growth. It introduced a distributed protocol that guarantees almost definitely easy access to ad-hoc nodes. The critical sensor density is dependent on its simulation environment. Since the proposed approach uses sensor coverage as a means of net communication, the percolation of
the former and its percolation are based on the relationship between the radius of the sensor and the sensor field. The solution also integrates p’s location on a variety of sensor disks, which cross a specific sensing disk. Then, the critical covered zone fraction is calculated and deduced for rapid sensor cover percolation using a probabilistic approach.

### 5.1 | Discovery coverage models

In order to classify sensor networks, incidents should happen at any location. By its probability of detection in combination with the detector function, the sensor output can be expressed. The likelihood of a single sensor finding a space point is also linked to, among other things, the distance between it. Nonetheless, it is no longer possible to merely use the detection probability of a space point concerning a variety of sensors to detect the moment with each individual sensor. Price fusion or decision fusion can also remove the likelihood of identification. In the literature, a range of detection scope models focused on multiple case scenarios and detection strategies were suggested. Consider a general signal spreading model in which the signal parameter – including a signal spread (i.e., a sound source intensity) – is damped. The Senz sensor readings are found in the hypothesis whether that the target is present (H1) or not (H0).

\[
H_0 : L_p = M_p 
\]

\[
H_1 : L_p = \theta / ED_p + M_p
\]

where \( \alpha \) is the attenuation exponent,

\[
L_p = \theta / ED_p + M_p
\]

### 5.2 | Sensing quality coverage models

Many investigators claim that with a growing distance from the sensor, the sensor reduces its sensing efficiency. Furthermore, to report these diluted sensory values, a reduced advance coverage model is used. A coverage model gives an example

\[
f(d(sensor, z)) = \frac{\text{constant}}{ED^\alpha(sensor, z)}
\]

where \( \alpha \) is a track attenuation exponent and \( \text{Cons} \) is a constant, and as one sensor is a non-negative feature, all spatial coverage is used. The slowed-down disk coverage model is also shown. It’s more comprehensive than that as it is closer to the sensor.

\[
f(ED) = \sum_{i=1}^{n} \frac{\text{constant}}{ED^\alpha(sensor, z)}
\]

In some instances, the calculation of the previous simplification equation only involves sensors near a space point.

### 5.3 | Approximation coverage models

Signal parameters are also significant in the evaluation of sensor networks. The estimation error can represent the sensing efficiency of the sensor in the sense of an estimation application. Among other variables, the distance between spaces is often related to a measurement error by a single sensor. However, if multiple sensors are used for estimating, it will no longer merely be calcite as the addition of the point estimate error concerning each sensor to the estimation of the parameter of a specific signal at a space level. Alternatively, various methods of computation can be applied, and errors of estimation often vary. To explain a sample range, a basic signal estimation scenario is used. For any space point \( z \) a signal arises, and the signal parameter attenuates as well as the signal distribution. The acoustic amplitude can, for example, be caused by an engine or a gas barrel leakage. The amplitude is attenuated as it propagates for a magnetic wave-like acoustic wave. The Senz sensor is used for calculating the signal parameter

\[
l_z = \frac{\theta}{ED_p^\alpha} p
\]

### 5.4 | Analysis of connectivity

The originality and variations of this analysis include the following:

- Sensors move reactively during this mission and each sensor can cover more than one target, which in practice, is more common, but also complicates the problem.
- Targets are used to locate the closest sensor to prevent blind rivalry between mobile sensors. Therefore, as our approach produces the objectives in accordance with their location, the static targets do not need re-calculation. It makes the suggested solution less complicated.
- Mobile sensors destinations that should be measured with our algorithms are unknown. If mobile sensors travel to these destinations, they fulfil the target coverage and network connectivity.
- The results of simulation experiments, providing guidance for practical engineering and in theoretical terms to develop mobile sensor networks, have been used for analysis and evaluation.

### 5.5 | Combined sensing connectivity

There are two centric disks that represent the disk using \( r \). This kind of framework demonstrates the dual characterisation by the behaviour of the sensors based on the
cooperation process. The number of sensors depends on the radius of the sensor drives; while communications are connected to the radius of the transmitted disk. Previous studies have shown that the concept of sensor coverage and connectivity is dependent. The protocol proposed helps us to research the similarities between these two principles from the percolation theoretical standpoint. It can be seen as a connected percolation problem for continuum and this section must be concentrated for the success of our FPMC protocol in various sub-regions. In the 2, 4, 8, 16 and 32 sub-regions, WSN partitions are considered. Therefore, in five variants of the FPMC specification, the DESK, and GAF, are refused. Simulations without dividing the interest region, cases that lead to a centralized approach, are not shown, as high running times are needed for resolving the whole program and thus too much energy is consumed. Two different methods equate our protocol. DESK is an algorithm of scope that is entirely distributed. The second is to split the area into fixed positions, known as the GAF.

5.5.1 | Connectivity for WSN

Round intersection algorithm based on a related coverage node collection enhances the local area coverage algorithm circular intersection. Successful node set selection is carried out using the time-round method. The whole network service process is broken into many ‘rounds’. The active nodes pick the step and run process of each round. Every round will be split into two phases. Both intersection-determined nodes in active nodes calculate their own state and render active round node sets in their current node selection process. The active network set nodes for data management and transmitting are liable throughout the running point. Each node is woken up randomly during the active node selection stage. Upon waking the node up, state details will be sent through active neighbour nodes, which mostly include, in a certain period of time. Node uses a circle cross-section coverage decision algorithm to determine if it is protected by active neighbourhood node collection based on obtained state knowledge from the neighbouring nodes. If the coverage criterion is fulfilled, it indicates that there is a CCc node collection covering this node. The node thus proceeds to determine whether nodes are linked in the cover node collection, that is, if the current CNc covers node collection is related. If the criterion is fulfilled, it indicates that this node is protected by a neighbour's attached node and the node will go to sleep or that it is in active state to accept an ambient neighbourhood alert.

Let the nodes can be represented as

\[ \text{Node}_k \]

removes the number of nodes on the condition of \( i^{th} \) algorithm is implements

\[ \text{Node}_k \]

remove the \( i^{th} \) node

\[ \text{Level}_{i+1} \]

remove the \( i^{th} \)

Represent the wake up time in random manner before staring the round

### Algorithm ICC for each \( \text{Node}_k \)

Begin
While (Check the Node is not dead condition)
Set the Node waiting time
If (check the node expire condition)
Check the sleep time in random manner
Terminated the conditional statement
Compute the all active node

\[ \text{Node}_{k+1} = \text{Node}_k + \{v\} \]

Terminated the conditional statement
Compute the ICC approach
If enclosed by the \( \text{Node}_k \)
Compute the Connected Coverage Set
If \( \text{CNC} = \text{CCc} \) Then
Set sleep time \( T_{sleep} \) and sleep state for Nodec;
Wait until \( T_{sleep} \) is not Terminate and Nodec go to rest node;
While Ends;
Otherwise
CCc not associated and node c active state;
Set active state to nodec;
If ends;
Broadcasting node state message to node v;
Node c busy;
If ends;
While ends;
Iteration Ends;

5.6 | Coverage ratio

Furthermore, the simulation for fusion protocol for improving coverage and connectivity WSNs using MATLAB is performed. The cumulative coverage is deployed for 150 nodes. The first 30 points indicate a marginally better coverage ratio for DESK and GAF than for FPMC. The number of active nodes explains it easily: our protocol optimisation method allows fewer nodes than DESK and GAF, resulting in a small decrease in the coverage ratio. For FPMC, the coverage rate for periods is rapidly falling to NULLS in period 18 (46). Furthermore, after the implementation of large number of sub-regions (8 to 32 regions), the protocol allows small numbers of nodes to be extended and extends network life.

Energy consumption, based on our findings, we concentrate on the protocol’s FPMC and equate their energy usage with the approaches DESK and GAF. Then, the energy consumed by each sensor node for different network densities is calculated according to its successive status. Protocol 50 determines the amount of energy expended, and the field coverage is over 50% (95%). For the various output metrics, the same network sizes are used (Figure 1).

The sensing range for any sensor is the distance between sensor and the object whose physical attributes is to be detected or classified [42–44]. Sensing node is the active sensor which is performing its functionality of sensing and classification. On the other side, sleeping node is the node which is passive because the sensing object is not in the sensing range [45].

It means that, in FPMC, while the more significant network allows the number of periods with the lowest level
of coverage to be increased, the overhead connectivity and complicated management issue lead to an increase in energy costs per word. However, compared with DESK and GAF, the proposed method has a proper execution overcast time. The creation of the period with the size and numbers of sub-regions is another critical aspect to examine. Therefore, the average runtime is reported in seconds needed for each version of our protocol work for optimisation of the WSN network. During the life cycle of the network, the execution times are shown. The lifespan of the network, regardless of the protocol, increases with the corresponding node number. A high density of the network means the redundancy of multiple nodes and can thus prolong the existence of the network.

In Figure 2, FPMC, GAP and DESK are compared on the basis of rounds completed, remaining energy in network DESK, and remaining energy in network GAP single hop in network FPMC dual-hop. After the every iteration, the energy is decreasing. On the eighth iteration, the remaining energy in FPMC, GAP and DESK becomes zero. In Figure 3, the packages sent to BS increases exponentially to range of 1300 rounds, then it becomes constant. The number of dead nodes (Figure 4) reached to steady-state on 1300 rounds. It shows that the number of a
packet sent to BS station is directly proportional to the number of dead nodes. Similarly, Figure 5 represents the relation between the number of nodes and net sum of energy and it reveals that the sum of all energies decreases exponentially. And after a certain number of rounds, it reaches to steady-state.

6 | CONCLUSION

A crucial issue in WSN consists of coordinating sensing operations of the various nodes to cover both the field of interest. The limitations inherent in the supply, communication, and sensor node computer technologies include protocols to elevate resources to execute a detecting process. We resolve following delinquent by proposing an approach based on a two-stage strategy: a multi-level clustering protocol called maximises coverage and lifetime achievement. The option of a top node in the proposed protocol consists of a programming operation of a sensor. The proposed approach is contrasted by two other performance indicators, such as coverage ratios or network life, using many other performance metrics. In order to subdivide the field of interest, we also analysed the effect of the number of sub-regions chosen, considering the different network dimensions. The studies show that more significant numbers of sub-regions improve people's lives. Finally, the active sensor nodes in particular region, minimum WSN nodes movement and FPMC protocol will enhance the network coversages.

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