Date of publication MAR-29, 2021, date of current version JUL-18, 2020
www.computingonline.net / computing@computingonline.net

*Print ISSN 1727-6209*
*Online ISSN 2312-5381*
*DOI 10.47839/ijc.20.1.2097*

# Farmer Dissemination of Seeds (FDS) Deployment Method Applied to Simulated Leach Protocol

**HESHAM A. ALABBASI, AHMED SALIH MEHDI, ALAA HUSSAIN ALTIMIMY**
Mustansiriyah university, College of education, Iraq, Baghdad
(e-mail: hesham.alabbasi@uomustansiriyah.edu.iq, ahmedalzuhairi60@gmail.com, aaltimimy@yahoo.com)

Corresponding author: Hesham A. Alabbasi (e-mail: hesham.alabbasi@uomustansiriyah.edu.iq).

The authors would like to thank Mustansiriyah University (www.uomustansiriyah.edu.iq) Baghdad Iraq for its support in the present work.

**ABSTRACT** Recent communication technologies in the Wireless Sensor Networks WSN enable us to implement and construct various physical sensing nodes with electronic circuits for transmitting and receiving tasks. Low-Energy Adaptive Clustering Hierarchy LEACH is a well-known routing protocol used and implemented in researches and articles; also, there are various attempts from the researchers to modify it to achieve the best results. Since almost all of the articles considered deployment either predefined or randomly depleted for the whole reign of interest RoI. A sophisticated random node deployment method is proposed, named Farmer Disseminating the Seeds FDS, the farmer walks with almost uniform steps and parallel lines to cover the whole RoI. A formation of a uniform grid with deviated random local distances from grid crossings considered as a predefined number of normal nodes with one advance node that has double battery energy. FDS is used to improve the importance of deployment methods as an additive parameter in estimating lifetime and energy consumption in routing protocols. Traditional random deployment and FDS methods are compared.

**KEYWORDS** wireless sensor network WSN, LEACH protocol, FDS method, deployment method, routing protocol.

## I. INTRODUCTION

MULTIPLE fields are considered to achieve many technical and practical requirements necessary for wireless sensor networks and their sophisticated applications. It appears that there are no limits for those applications predicted like in space between planets or on their surfaces [1] which are very promising and gathering Nano-sensor technology with WSN facilities [2]. These fields include deployment methods of nodes and repositioning them, electronics of nodes, including communication techniques, protocols and equipment [3], the technical industry of batters with the harvesting of energy [4], routing algorithm and information transfer through the network [5, 6]. WSNs are applied in civilian fields like monitoring fire in the forest, weather fluctuations, and military tasks like management of army missions, prevent intrudes of the forbidden area against the enemy forces and so on [7, 8].

The application of WSN requires for suitable cost, good connectivity, long lifetime, ability to be applied at a large area and overcome obstacles and terrain factors [9].

### *A. LOW-ENERGY ADAPTIVE CLUSTERING HIERARCHY METHODOLOGY AND HISTORY*

There are many access routing protocols for wireless sensor networks, one of the oldest sophisticated routing protocols is the low-energy adaptive clustering hierarchy LEACH [10-12]. It considers reducing routing paths by creating cluster heads, electing each epoch and collecting data from normal sensing nodes associated to them. This process is mediate time-division multiplexing table cluster head sends to inform each associated node when it sends data within time slot defined by the table. After many rounds cluster heads aggregate data information and send them to the base station, since, sending data packets from cluster heads to base station consumes more energy. A mechanism of a random election of cluster heads is used to balance energy consumption between nodes. Too many interactive communication packets are needed to prepare the clustering form of the network although a random election of cluster heads has a drawback of bad distribution of cluster head and it does not appreciate minimizing the distances of overall paths established.

Over the last twenty years, many primary and secondary ways of activating and handling to overcome the disadvantages of this routing protocol were suggested, submitted and modified. Some of them related to this paper are in [13-24]:

1. Insertion of random deployment advanced nodes with duplicated battery energy to enforce the structure of the network.

2. Balance Selection of clustering heads according to residual energy of node battery, the sum of the distances with node neighbors and the distance between cluster head and base station. This approach is called Balance LEACH-B.

3. Subdivide region of interest RoI into zones, for example, four rectangular or more zones or subdivided RoI into circular rings concentrated to the base station then select cluster head nodes within that zones equal to other numbers or increase when they are closer to the base station.

4. Consider two levels of cluster heads TL-LEACH where information will be transferred from the second level cluster heads to the first level cluster heads to the base station. Utilize multi-hop routing techniques MR-LEACH and IMR-LEACH that are accepted as one of the efficient and important solutions that minimize the total sum of communication paths.

5. An assistant node close to each fixed selected cluster head acts as a vice node to it. This method is called Vice V-LEACH. When the main cluster head energy goes down to a certain level sends an assisted node will tack its role as a cluster head and the process continues.

6. Fuzzy logic and artificial intelligence (genetic algorithm) methods are used to select cluster head nodes according to energy levels, number of connections and so on. The number of cluster head nodes is also estimated to minimize the number of connections and fulfill any intelligent aims of that network.

7. Knowing coordinates of all nodes or at least cluster head nodes by any method of localization like GPS or the received signal strength indication (RSSI) methods then send these coordinates and the energy of all nodes to the base station. The base station has calculation power and energy to estimate the best selection of cluster head and normal node associations. These approaches are called Centralize LEACH-C and LEACH chain-based routing protocol LEACH-CC.

8. Two base stations may be used, this preparation facilitates the geographic information and employed multi-paths routing.

9. The base station or cluster head nodes granted mobility to prepare suitable localization and coverage of the network. These treatments are recent trends in research.

10. Beacon or fixed nodes with specific capabilities, are used to interact with normal nodes to estimate the location of nodes. Recovering out range nodes is also considered.

11. Adaptive energy transmission range is also considered for keeping energy consumption efficient distance and energy DE-LEACH.

12. Various routing methods were established like Threshold sensitive energy-efficient sensor network TEEN, Power-efficient gathering in sensor information system PEGASIS, Stable Election Protocol SEP, Distributed energy-efficient clustering DEEC and so on.

### *B. NODE DEPLOYMENT ATTEMPTS IN WSN*

It is obvious that not many papers considered random deployment for static nodes in WSN. Some of them mentioned uniform or poison distributions covering all the areas under attention [25]. More papers address the statistical approach and then used deterministic re-positioning methods to achieve coverage or connectivity [26]. Although considering predetermined ways of scan path come inclusively with the applications of other fields of researches like ultimate counts of nodes for total coverage, discovering the uncovered area, allocates node locations, maintaining defected nodes, recharge depleted batteries, keeps connectivity of the network and so on [27, 28].

There are many strategies addressed for node deployment in WSN:

(1) Simple WSN Node Diffusion Distribution, the deployment of nodes was done by release nodes from a predetermined height over a base station BS, so higher node densities are concentrated near BS. This method is suitable for communication information packets traffics in the network. This method is not considered as a realistic approach for wide-area coverage and the huge number of nodes since higher altitudes are needed and their consequences. Using a helicopter and hanging each node with parachute maybe counted [29].

(2) Uniform Density of WSN Node Distribution, the deployment of nodes was simulating by constant node density all over a regarded area. It is a more deterministic way or maybe nodes are relocated by moving node after deployment [30].

(3) Power Density of WSN Node Distribution, the deployment of nodes was applied according to power low of distribution. The density of nodes is higher near BS and reduced according to predefined exponent value. Controlling the exponent value of the distribution is the more suitable way for specific applications [30].

(4) Sensor Node Distribution, this method subdivides area under consideration to hexagonal cells and each cell includes only one sensor node. The teamwork revels that nodes in the area under consideration keep working and unconnected groups of nodes in other methods, which means the goal of keeping the network working in a larger area is

more important than how long node lives. It is important to keep node connectivity than the last node live longer since isolated nodes do not function properly [31].

### *C. HISTORY OF CHALLENGES FACING PRACTICAL STOCHASTIC DEPLOYMENT OF NODES ALL OVER THE AREA OF INTEREST AOI*

In earlier researches, no serious attention was paid to node deployment accomplishing, the first attempts were made by Arial dropping nodes using helicopter or alternative from a specific height, almost done from one point and it was anticipated to spread them all over the AoI uniformly [32]. These suggestions deviate from reality. We can summarize many treatments to solve the problem:

First: deployment of node connected to a parachute to a bounded falling speed of nodes and ability to predict falling place by estimating wind speed, rain effects and terrain obstacles [33-35].

Second: movement of nodes after falling using different estimation methods:

(1) Virtual Force to Keep Connectivity Method VFKCM: It includes moving mobile or anchor nodes according to virtual force similar to attraction or repulsion physical forces with the inverse square distance between nodes and BS to perform uniform equidistance distribution over AoI. This is down by estimating force direction to each node. Floor Divided Modification was also added to reduce the total movement of nodes by sub-dividing AoI into small areas and doing modification accordingly [36].

(2) Relocation of Nodes According to Predefined Calculation Method RNAPCM:

It includes moving mobile or anchor nodes according to geometric estimations to keep a minimum of total distances between nodes and with BS [36].

(3) Hybrid Method: It is a combination of the two methods, force, and geometrical factors [36].

(4) Sub-Regional Push-Pull Method SRPPM: It includes subdividing RoI into hexagonal cells, moving it and allocating each node in the center of that region. It is called Tiling [37].

Third: Stochastic Deployment by Group of nodes according to grid crossing and grouping nodes according to grid crossing [38]. These methods give rise to more reliable, uniform and practical treatments of stochastic node deployments especially for overall coverage called Blanket coverage [39].

To achieve group, grid and group grid node deployment the process needs to apply one of predefined scan path methods [40, 41]. The predefined scan path methods are:

(1) Zig zag Scan Path ZSP: While deployment of nodes movement of helicopter or any alternative devices with a zig zag path is used to cover AoI. Separation between two lines will be twice the maximum transmission radius of node, or the main distance of dispersion if group of nodes are deployed. The clearance at the edges will be half that radius [40].

(2) Parallel Lines Scan Path PLSP: This path is similar to ZSP except without deployment when transfer from one parallel line path to the anther. This method leaves the edges of AoI partially covered to gain less node deployed and less interfere of node coverage at edges. So this method is suitable to application when the coverage of the edges is paid less attention [40].

(3) Concentric Scan Path CSP: Deployment path will be as closed curves concentric about a center where a BS may poison. Distance between parallel curves is twice the maximum radius of node transmission or twice the main distance of dispersion of the node group. The clearance at the edges will be half that radius.

(4) Spiral Scan Path SSP: This path is similar to CSP but without discontinuity of deployment when transferring from curve to another curve. This method can be done more smooth although more nodes and interfere of node coverage [40].

(5) Hilbert Scan Path HSP: To get adjacent node to gather an n dimensional curve is used. This method needs to implement sophisticated device [41].

Scan path explained are only one- dimensional so they may face some alignment problems, especially to allocate each node to another. To solve this problem and to get more uniformity of deployment double scan path is considered.

Using complex scan paths may open extra sophisticated methods to deal with deployment of nodes. A lot of teamwork handles mobile nodes to consider obstacles and terrain.

Although many papers highlighted scan paths but they used them to estimate paths for moving robot, vehicle or human to reach over all AoI where the deployed nodes for localization by Received Signal Strength Indication RSSI or alternatives, maintenance especially charging batteries and may prepares connectivity [42].

Sophisticated deployment of nodes using predefined scan path and using any strategy was not treated enough in the proceeding papers. In other words, no actual study pays attention to measure random deployment methods.

The proposal gathering discreet group grid is a parallel scan path with heterogeneous node (using one double battery capacity node among predefined number of normal nodes). This heterogeneity gives WSN the flexibility to deal with different routing algorithms and to maintain enough skeleton of the network for longer functioning all over RoI. This new deployment was tested by LEACH routing protocol. The results are compared with a uniform deployment to the total area of interest by simulation both deployments. Introducing farmer dissemination of seeds random deployment method will allow this approach to be used in parallel or integrated with the rest of the handling mechanisms.

## II. SIMULATION OF LEACH PROTOCOL

There needs to be an adequate summary of references to describe the current state-of-the-art or a summary of the results.

Practically, to simulate the LEACH algorithm we used MatLab©2017 to create multi-functions m-files and tested with numbers of parameters, a brief explanation of the LEACH algorithm 1 is:

### Algorithm: LEACH algorithm

```
Begin
Step 1: Set model parameters; (no. of nodes, the
        dimension of the area, cluster header
        percentage, advance nodes percentage, …)
Step 2: Define random x and y locations across RoI
        for the total number of nodes and mark
        predefined percentage of them (10 percent)
        as double battery capacity.
Step 3: Starting a clear round with reset all
        election flag; (Flag G = 0 reset all
        elections).
Step 4: Starting Epoch with election Cluster Heads
        CHs by LEACH standered election criteria
```

$$\frac{p}{1-p*(mode\,\frac{r}{round\left(\frac{1}{p}\right)})}, \qquad (1)$$

```
where p is probability of CHs, r is a round number.
        Then incrementing election flag; (Flag G =
        round number after election).
Step 5: Cluster Heads CHs send "HELLO" packets to
        Base Station BS and all Normal Nodes NNs
        receive them within the radius between CH
        and BS.
Step 6: Each NN estimates the nearest CH and sends
        the "HELLO" packet with a distance between
        NN and associated CH.
Step 7: Only the nearest CH will receive" HELLO"
        packets of associated nodes.
Step 8: Each CH constructs Time Division Multiple
        Access TDMA table, that determines the
        sequence of a time slot to each NN
        associated to that CH and sends "HELLO"
        packets to BS and NNs with TDMA table.
Step 9: NNs receive "HELLO" packets with TDMA table
        and recognize its Timing Slot.
Step 10: Each NN sends the "DATA" packet to
        associated CH.
Step 11: CH aggregates "DATA" packets (spend
         energy) and sends the "DATA" packet to BS.
Step 12: If Epoch Not End and number of packets
         send < predefined number of packets per
         Epoch Then Go to step 10.
Step 13: If All NNs are dead or total predefined
         rounds are exhausted then
                End the simulation process.
    Else
Step 14: If predefined rounds are exhausted then
                  Go to step 3
              Else Go to step 4.
Step 15: Estimate statistical results.
End.
```

## III. Simulation of FDS random deployment

Farmer Disseminating the Seeds FDS random deployment is not a routing algorithm. It is a way to realize the simulation of how to randomize the distributing sensor nodes in WSN. Almost all simulation methods used a random distribution of nodes all over the entire area, in spite of it is impossible to apply it actually since depleted sensor nodes from high amplitudes or with force may damage the nodes and do not achieve covering the regions of interest RoI as claimed.

Simulate farmer disseminating of seeds distribution is more reliable and can be applied and expanded. The farmer walks in uniform regular steps and throws a fist of seeds at almost equal distances then moves to near parallel trajectory and repeat spreading seeds until he covers the whole farm. To simulate farmer action, a regular uniform grid is considered and distributed a predefined number of sensing nodes including one advanced node with duplicated battery energy at each grid crossing. FDS distribution can be controlled by the determination of deviation factor, the number of nodes, and the shape of paths and verified more than one stage of distribution with different parameters. The following algorithm 2, represents the FDS method:

### Algorithm 2: FDS Method

```
Begin
Step1: Set length (l), width (w) units, no. of nodes
       (n) nodes, grid crossing distance (d) units,
       percentage of advance node (p) to the total
       number of nodes and deviation values.
Step2: Estimate average value of nodes for each
       grid crossing and calculate the approximate
       number of total node for simulation:
           Average no. of nodes/ grid crossing
       (Anc.) =
           Integer (no. of total nodes (nT.)/no. of
       grid crossing).
           Post no. of total nodes = Anc. * nT.
Step3: Arrange horizontal and vertical number of
         grid crossing multiply by Anc. to nearest
         value to the total number of nodes. For each
         crossing estimate random x, y coordinate
         deviation using MatLab© predefined
         functions for each of Anc. node from that
         crossing and chose random node from them to
         double battery capacity
Step4: If estimated nodes are larger or less that
       the amount of nodes increase or decrease nl
       nodes, nw nodes.
Step5: repeat step4 until the total number of nodes
         is within the limits of setting number of
         nodes.
Step6: Use random function to generate deviated
         distance between random node and associated
         grid crossing.
Step7: Randomly select one node from normal nodes
         associated with each grid crossing to be the
         advanced node. Store coordinates and type
         of node in structured variable.
Step8: Repeat step6 and step7 for all grid
         crossings.
Step9: Use estimated number of advanced nodes and
         normal nodes to set new structure variable
         to generate traditional method of deployment
         all over the area with the same percentage
         of advanced nodes for compatible capability
         of the two systems.
End.
```

## IV. PROPOSED APPROACH PREPERATIONS

A lot of researches tried to modify LEACH routing protocol, although almost all these researches were intended to cover the whole area under consideration by applying random uniform deployment of sensor nodes. In practical this process cannot be applied since throwing sensor nodes from high altitudes or a big surge force from one location cannot allow achieving any uniform random deployment fitting to the target area.

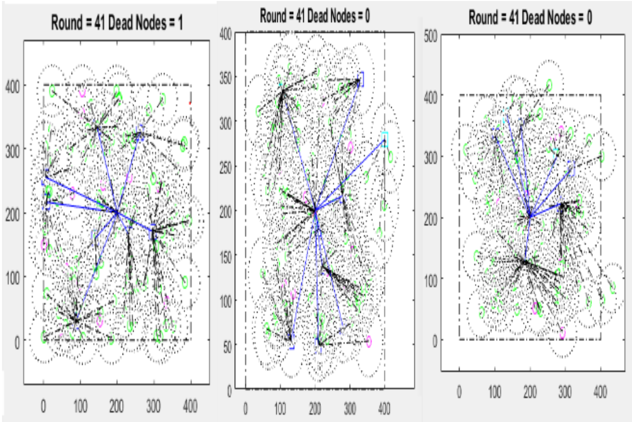
Therefore, preparation is made to test the deployment of a predefined number of nodes to a uniform grid across the area, this process imitates the mechanism of a farmer disseminating the seeds FDS across the field. Ten nodes are depleted which is fixed deviated random local distance at each grid crossing included one advanced node with double battery energy capacity, this maintains 10% of advanced nodes.

The preparations of multi-functions m-files using MatLab© program were achieved to compare the new depleted approach and the proper LEACH routing algorithm with equal normal and advanced nodes used both. A relatively larger area is considered to assure faster processing rhythm since it increased energy dissipation while communication interactions and node energy deployment needs to arise within a moderate period. The protocol frameworks are emphasized especially exchanging of communication packets which are achieved by many stages as pointed in the proposed approach. Two types of messages are considered as well known in this approach. First, the invitation “HELLO” packet to announce nodes of less order by information assortment synchronization between nodes or to inform cluster head which is the nearest normal node to it. Second, the “DATA” packet that sends sensing information from normal nodes to cluster head, aggregates them then sends them to the base station. New cluster heads will be reelected and the process will be restarted again.

MatLab m-files are coded to contain both methods executed at the same file at the same time then the results are compared with each other. The results include elected cluster heads and their connections to normal nodes are drowned to the base station, virtual dote circles with speculating radius are drowned about each node to show an approximation of coverage sensing area and their intersections. Recording of number of live nodes, number of packets communicated between nodes for types, average, and the sum of energy of all live nodes, number of elected nodes as cluster head in each selection and number of dead nodes for each round.

## V. EXPEREMENTAL RESULTS

Firstly, random deployment in both traditional and proposed approaches are prepared by using Matlab m-files codes for the mathematical simulation. Fig. 1(a) shows the random deployment of 120 nodes all over the area of 400 x 400 units squared. The FDS approach shows a shortage of covering area when the amplitude of dispersions is equal to 0.4 as shown in Fig. 1(b), while Fig. 1(c) shows out of area boundaries when the amplitude of dispersions is equal to 0.6.




(a) Over all area (b) FDS with divergence = 0.4 (c) FDS with div = 0.6

Figure 1. Deployment of 120 nodes in area of 400x400 units squared.

Adding 10% of advanced nodes to the network for enhancing life time of the network and giving flexibility to manage it, this is applied in each traditional algorithm and the proposed approach node distribution with equivalent capabilities. Measurement of Standard Deviation (SD1 for traditional distribution and SD2 for FDS approach), and Mean value (M1 for traditional distribution and M2 for FDS approach) are mentioned. Fig. 2 shows that the number of live nodes decreased in the first period in a limited region while the remaining nodes enforced with advanced nodes keep living a relatively considerable period.

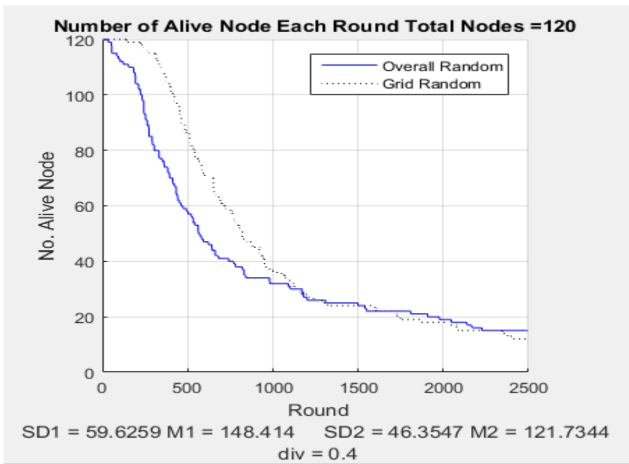
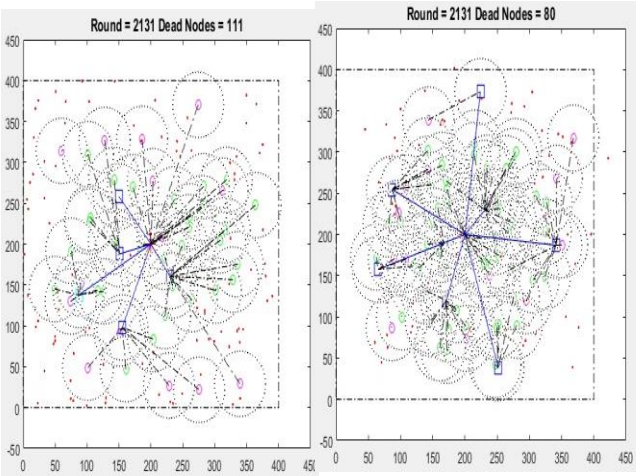



Figure 2. Number of live nodes each round for 120 nodes and div = 0.4

The nodes extreme far from cluster heads are soon dead, while stable long-life of remaining nodes happened according to stay living of advanced with normal nodes nearest them as shown in Fig. 3(a & b).




(a) Over all area (b) FDS with div = 0.4

Figure 3. Extreme distance nodes are dead and part of area is covered by living nodes enforced with advance nodes. Total number of nodes 120 in area of 400x400 units squared.

Estimating standard deviation and the average distances between all nodes and base station in traditional distribution and the proposed approach show that there is no direct evidence for any strong relation, although the amplitude of dispersion which is the measurement of the distances between normal nodes and nearest cluster heads is a dominant factor as shown in Fig. 2 with dispersion factor equal to 0.4, while Fig. 4 with dispersion factor equal to 0.6 shows the performance degradation of FDS approach.

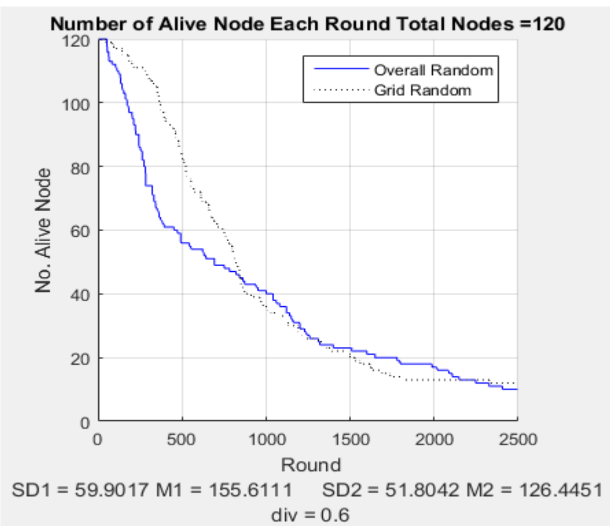
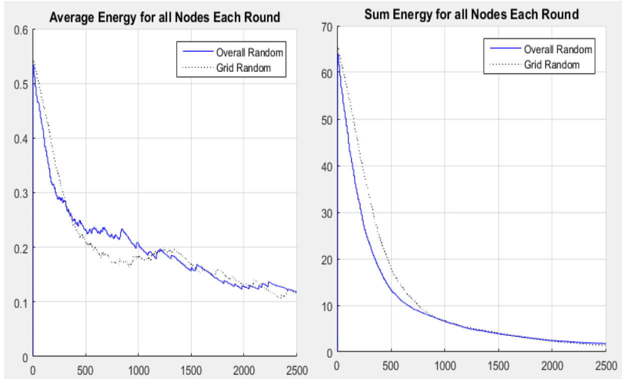



Figure 4. Number of live nodes each round for 120 nodes and div = 0.6

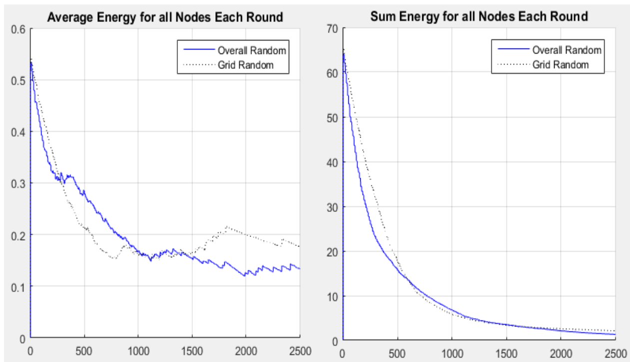
FDS proposed approach shows that its energy dissipated according to communication interactions is more efficient if the deviation value is equal to 0.4 as shown in Fig. 5(a & b).




(a) Average Energy (b) Total Energy

Figure 5. Energy each round for 120 nodes in area of 400x400 units squared, div = 0.40

Using dispersion factor equal to 0.6 average and total energy tends to be less efficient than traditional behavior as shown in Fig. 6 (a & b).

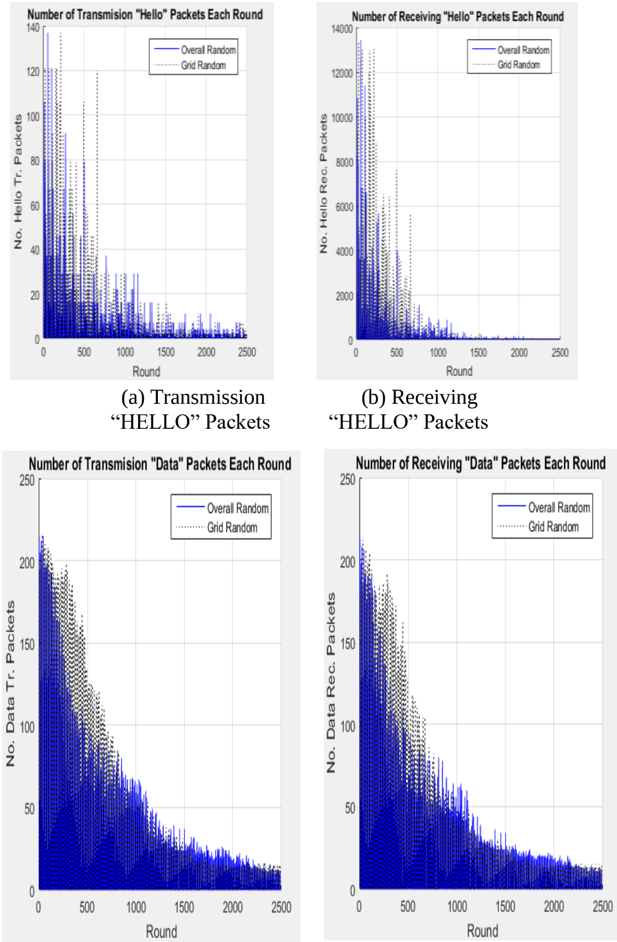



(a) Average Energy (b) Total Energy

Figure 6. Energy each round for 120 nodes in area of 400x400 units squared, div = 0.6

Network activity is more important when the last dead node occurs, since if an insulated node still living has no meaning, while connected nodes across enough area can maintain active sensing and effective communications for a longer period as shown in Fig. 7 (a, b, c & d).

The numbers of interactive communication packets are different according to their types, number of living nodes, and number of elected cluster heads in each round as shown in Fig. 8. Each election of cluster heads initiates communication activities like sending invitations to normal nodes, estimates association between the normal node and nearest cluster head, informs cluster heads and sends TDMA table from cluster heads. Although data packets remain as a limited number of messages while invitation messages maybe thousands of packets as shown in Fig. 7.




(a) Transmission "HELLO" Packets (b) Receiving "HELLO" Packets

(c) Transition "DATA" Packets (d) Receiving "DATA" Packets

Figure 7. Interactive communication packets each round for 120 nodes of area 400x400 units squared, traditional and FDS with div = 0.4

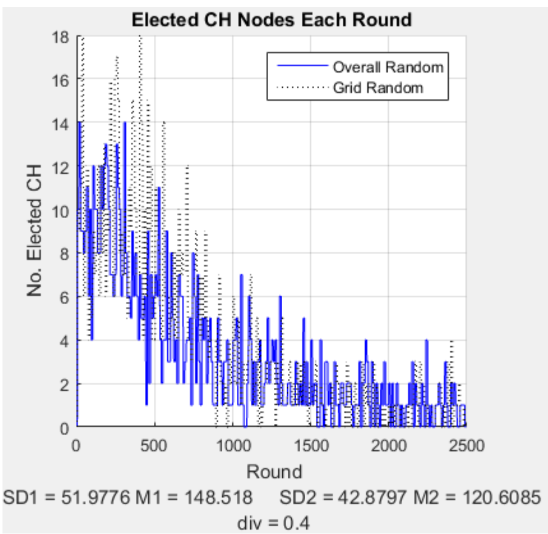



Figure 8. Number of elected cluster head nodes each round for 120 nodes for traditional and FDS with div = 0.4

## VI. CONCLUSIONS

Almost all LEACH routing methods that seek solution to overcome the disadvantages of the method did not notice that random deployment of nodes across the total area cannot be true in practical process because immediate throw of all sensor nodes once don not cover the regular rectangular area. Using Farmer Disseminating the Seeds LEACH (FDS-LEACH) approach is more realistic comparing to overall deployment method. Other treatment details are not applied to routing protocol. The simulation shows that FDS depletion is ideal but can not fit region of interest RoI and has a margin of randomness either larger or smaller than the area under consideration. Therefore, more treatments are needed by decreasing the region of deployment or limiting deviation factor which therefore decreases the overall coverage area. Using a predefined way of random deployment according to the proposed LEACH approach will increase thoroughly network efficiency. There are three phases of interactive communication between elected nodes and normal nodes each phase needs to estimate transmission consuming energy. To avoid too many rounds in simulation program fairly large area was used and more energy consumption was employed each round. At the first period of rounds extreme distance nodes to elected cluster heads were dead. At the second period of rounds the network was stable for fairly long period, this is because the skeleton of the network was enforced by the advanced nodes running and covering parts of the area under consideration. Covering an area that can be considered as good as enough to fulfill network tasks. This phenomenon was noticed in both traditional and FDS deployment methods because of advanced nodes.

The FDS deployment approach especially when the deviation of nodes is less than 0.5 tends to increase life longevity of nodes and so maintains communication activates longer and the overall life of the network compared with the traditional method.

FDS deployment approach and taking care of how to make the deployment can be considered as one way to complete handling the disadvantages of LEACH and other routing algorithms. Ensuring stability on the basis of the proposed protocol requires application of this method to more protocols and sophisticated treatment of boundary to RoI is needed.

## References


[1] D. Benhaddou, X. Yuan, and M. A. Balakrishnan, "Wireless sensor network (WSN) in space applications," NSTI-Nanotech 2009, www.nsti.org, ISBN 978-1-4398-1782-7, vol. 1, pp. 513-516, 2009.

[2] N. Kumar, A. Kumar, D. Chaudhry, "A novel approach to use nano-sensor in WSN applications," *International Journal of Computer Applications*, vol. 14, no. 2, pp. 31-34, 2011. https://doi.org/10.5120/1814-2349.

[3] R. P. Narayanan, T. V. Sarath, and V. V. Vineeth, "Survey on motes used in wireless sensor networks: Performance & parametric analysis," *Wireless Sensor Network*, vol. 8, no. 4, pp. 51-60, 2016. https://doi.org/10.4236/wsn.2016.84005.

[4] J. K. Young, A Practical Guide to Battery Technologies for Wireless Sensor Networking, 2008, [Online]. Available at: https://www.all-electronics.de/wp-content/uploads/migrated/document/156235/411ei1108.pdf.

[5] X. Liu, "A survey on clustering routing protocols in wireless sensor networks sensors," *Sensors*, vol. 12, no. 8, pp. 11113-11153, 2012. https://doi.org/10.3390/s120811113.

[6] S. K. Singh, M. P. Singh, and D. K. Singh, "Routing protocols in wireless sensor networks – A survey," *International Journal of Computer Science & Engineering Survey (IJCSES)*, vol. 1, no. 2, pp. 63-83, 2010. https://doi.org/10.5121/ijcses.2010.1206.

[7] M. Pejanovićđurišić, Z. Tafa, G. Dimić, V. Milutinović, "A survey of military applications of wireless sensor networks," *Proceedings of the Mediterranean Conference on Embedded Computing MECO*, Bar, Montenegro, 2012, pp. 1-4. ISBN: 978-1-4673-2366-6.

[8] B. Rashid, M. H. Rehmani, "Applications of wireless sensor networks for urban areas: A survey," *Journal of Network and Computer Applications*, vol. 60, pp. 192-219, 2016. https://doi.org/10.1016/j.jnca.2015.09.008.

[9] G. Devi, R. S. Bal, and S. M. Nayak, "Node deployment and coverage in wireless sensor network," *IJIRAE*, vol. 2, issue 1, pp. 141-145, 2015.

[10] U. Khyathi, Ch. Subrahmanyam, "An improved LEACH algorithm based on wireless sensor networks," *International Journal of Recent Technology and Engineering*, vol. 8, issue 2S8, pp. 1623-1628, 2019. https://doi.org/10.35940/ijrte.B1117.0882S819.

[11] A. C. H. B. Wendi R. Heinzelman, "Energy-efficient communication protocol for wireless microsensor networks," *Proceedings of the Hawaii International Conference on System Sciences*, Maui, Hawaii, January 4-7, 2000, vol. 2, pp. 1-10.

[12] N. Saini & J. Singh, "A survey: Hierarchal routing protocol in wireless sensor networks," *Global Journal of Computer Science and Technology: ENetwork, Web & Security*, vol. 14, issue 1, version 1.0, pp. 33-39, 2014.

[13] M. Tong, "LEACH-B: An improved LEACH protocol for wireless sensor network," Proceedings of the IEEE 6th International Conference on Wireless Communications Networking and Mobile Computing (WiCOM), Shanghai, China, 2010, pp. 1-4.

[14] V. Loscri, G. Morabito and S. Marano, "A two-levels hierarchy for low-energy adaptive clustering hierarchy (TL-LEACH)," *Proceedings of the IEEE 62nd Vehicular Technology Conference*, 2005, vol. 3, pp. 1809–1813.

[15] A. B. Dogar, G. A. Shah, and M. O. Farooq, "MR-LEACH: Multi-hop routing with low energy adaptive clustering hierarchy," *Proceedings of the Fourth International Conference on Sensor Technologies and Applications (SENSORCOMM)*, 2010, pp. 262-268.

[16] A. Al-Zou'bi, Y. Khamayseh, W. Mardini, and M. B. Yassein, "Improvement on LEACH protocol of wireless sensor network (VLEACH)," *International Journal of Digital Content Technology and its Applications*, vol. 3, no. 2, pp. 132-136, 2009. https://doi.org/10.4156/jdcta.vol3.issue2.yassein.

[17] A. Karimi, S. M. Abedini, F. Zarafshan, S.A. Ral-Haddad, "Cluster head selection using fuzzy logic and chaotic based genetic algorithm in wireless sensor network," *Journal of Basic and Applied Scientific Research*, vol. 3, no. 4, pp. 694-703, 2013.

[18] X. H. Wu and S. Wang, "Performance comparison of LEACH and LEACH-C protocols by NS2," *Proceedings of the 9th International Symposium on Distributed Computing and Applications to Business, Engineering and Science*, Hong Kong, China, 2010, pp. 254-258.

[19] A. P. Azad, *Enhancing Network Life time in Wireless Sensor Networks Using Multiple Base Stations and Cooperative Diversity*, Master Thesis, Faculty of Engineering Department of Electrical Communication Engineering Indian Institute of Science, 2006. [Online]. Available at: http://wwwsop.inria.fr/members/Amar.Azad/thesis_1.pdf.

[20] H. Kim, "An efficient clustering scheme for data aggregation considering mobility in mobile wireless sensor networks," *International Journal of Control and Automation*, vol. 6, no. 1, pp, 221-234, 2013.

[21] R. K. Tripathi, *Base Station Positioning, Nodes' Localization and Clustering Algorithms for Wireless Sensor Networks*, Ph.D. Thesis, Department of Electrical Engineering in Dian Institute of Technology Kanpur, 2012, [Online]. Available at: http://home.iitk.ac.in/~ynsingh/phd/Y7104097.pdf.

[22] S. Kumar, M. Prateek, N. J. Ahuja, B. Bhushan, "DE-LEACH: distance and energy aware LEACH," *International Journal of Computer Applications*, vol. 88, no.9, pp. 36-42, 2014. https://doi.org/10.5120/15384-4072.

[23] P. Giri, Anjalipotnis, P. Tripathi, "Comparative study of LEACH, SEP, TEEN, DEEC, and PEGASIS in wireless sensor network," *International Research Journal of Engineering and Technology (IRJET)*, vol. 5, issue 6, pp. 822-826, 2018.

[24] K. Latif, M. Jaffar, N. Javaid, M. N. Saqib, U. Qasim, Z. A. Khan, "Performance analysis of hierarchical routing protocols in wireless sensor networks," *Proceedings of the 7th IEEE International Conference on Broadband and Wireless Computing, Communication and Applications (BWCCA 2012)*, Victoria, Canada, 2012, pp. 40-43. https://doi.org/10.1109/BWCCA.2012.108.

[25] H. Zhang and C. Liu, "A review on node deployment of wireless sensor network," *IJCSI International Journal of Computer Science Issues*, vol. 9, issue 6, no. 3, pp. 378-383, 2012.

[26] Y. Jiang, S. Xiao, J. Liu, B. Chen, B. Zhang, H. Zhao, and Z. Jiang, "Deterministic sensor deployment method for target coverage," *Hindawi Journal of Sensors*, vol. 2018, article 2343891, 2018. https://doi.org/10.1155/2018/2343891.

[27] W. Y. Poe, and J. B. Schmitt, "Node deployment in large wireless sensor networks: Coverage, energy consumption, and worst-case delay," *Proceedings of the AINTEC'09*, Bangkok, Thailand, November 18–20, 2009, pp. 77-84. https://doi.org/10.1145/1711113.1711127.

[28] P.-J. Wan, C.-W. Yi, "Coverage by randomly deployed wireless sensor networks," *IEEE Transactions on Information Theory*, vol. 52, no. 6, pp. 2658-2699, 2006. https://doi.org/10.1109/TIT.2005.862092.

[29] M. Reda, A. Mellouk, A. Aissani, "Random deployment of wireless sensor networks: a survey and approach," *International Journal of Ad Hoc and Ubiquitous Computing*, vol. 15, nos. 1/2/3, pp. 1-14, 2014. https://doi.org/10.1504/IJAHUC.2014.059905.

[30] M. Ishizuka, and M, Aida, "Performance study of node placement in sensor networks," Proceedings of the International Conference on Distributed Computing Systems Workshops, Los Alamitos, CA, USA, 2004, vol. 5, pp. 598–603. https://doi.org/10.1109/ICDCSW.2004.1284093.

[31] A. Sinha, and B. Pal, "Stensor: a novel stochastic algorithm for placement of sensors in a rectangular grid," Eureka in Kshitij, IIT Kharagpur, 10 pages, 2007.

[32] I. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks," *IEEE Communications Magazine*, vol. 40, no. 8, pp. 102–114, 2002. https://doi.org/10.1109/MCOM.2002.1024422.

[33] S. Mnasri, N. Nasri, and T. Val, "The deployment in the wireless sensor networks: Methodologies, recent works and applications," *Proceedings of the International Conference on Performance Evaluation and Modeling in Wired and Wireless Networks (PEMWN 2014)*, Sousse, Tunisia, November 2014, pp. 1-7.

[34] X. Yu, N. Liu, W. Huang, X. Qian, and T. Zhang, "A node deployment algorithm based on Van Der Waals force in wireless sensor networks," *Hindawi International Journal of Distributed Sensor Networks*, vol. 2013, article id 505710, 2013. https://doi.org/10.1155/2013/505710.

[35] V. Sharmaa, R. B. Patelb, H. S. Bhadauriaa, D. Prasadc, "Deployment schemes in wireless sensor network to achieve blanket coverage in large-scale open area: A review," *Egyptian Informatics Journal*, vol. 17, issue 1, pp. 45-56, 2016. A review," *Egyptian Informatics Journal*, vol. 17, issue 1, pp. 45-56, 2016. https://doi.org/10.1016/j.eij.2015.08.003.

[36] X. He, X. L. Gui, and J. An, "A deterministic deployment approach of nodes in wireless sensor networks for target coverage," *Journal of XiAn Jiaotong University*, vol. 44, no. 6, pp. 6-10, 2010.

[37] X. M. Guo, C. J. Zhao, X. T. Yang et al, "A deterministic sensor node deployment method with target coverage based on grid scan," *Chinese Journal of Sensors and Actuators*, vol. 25, no. 1, pp. 104-109, 2012.

[38] A. Thakur, D. Prasad, and A. Verma, "Deployment scheme in wireless sensor network: A review," *International Journal of Computer Applications*, vol. 163, no. 5, pp. 12-15, April 2017. https://doi.org/10.5120/ijca2017913521.

[39] Y. Z. Zhang, C. D. Wu, L. Cheng et al, "Research of node deployment strategy for wireless sensor in deterministic space," *Control and Decision*, vol. 25, no. 11, pp. 1625-1629, 2010.

[40] T. K. Mishra, A. K. Dass and S. K. Panda, "Enhanced path planning model for anchor-free distributed localization in wireless sensor networks," *Proceedings of the 2018 Fifth International Conference on Parallel, Distributed and Grid Computing (PDGC)*, Solan Himachal Pradesh, India, 2018, pp. 430-435, https://doi.org/10.1109/PDGC.2018.8745802.

[41] P. D. Dagwar, C. Bawankar, "Enhancement of localization algorithm in wireless sensor networks," *International Journal of Science and Research (IJSR)*, vol. 4, issue 6, pp. 1334-1337, 2015.

[42] C.-C. Chen, S.-B. Wang, "Node-Gosper curve-based unknown sensor localization using single mobile anchor in wireless sensor networks," *International Journal of Distributed Sensor Networks*, pp. 1-13, 2016. [Online]. Available at: https://doi.org/10.1177/155014775780101.

***HESHAM ADNAN ALABBASI*** *was born in Baghdad, Iraq in 1969. He received his B.Sc. degree in Computer Science in 1992 from Mustansiriyah University and his M.Sc. degree in Computer Science in 1999 from University of Technology, Iraq, Baghdad. He received Ph.D. degree in 2016 in Computer Science\ Software from Politehnica University in Bucharest, Romania. In 2004, he joined the faculty of Engineering\ Computers Engineering Dept. at the Mustansiriyah University in Baghdad. His recent research activities are Face Recognition, Emotions Detection, Body Motions Tracking with Kinect Sensor, Wireless Sensor Network Systems, Speech Signal Processing and Chaotic Modulation. Now he is a lecturer at the Mustansiriyah University, college of education, Iraq.*
*Orcid.org/0000-0003-2970-7942.*

***AHMED SALEH MAHDI AL-ALZUHAIRI*** *was born in Baghdad, Iraq in 1957. He received his B.Sc. degree in Computer & Control Engineering in 1979, from Technology University. M.Sc. degree in Computer Engineering in 1983, from University of Technology, Iraq, Baghdad. He joined the faculty of Engineering\ Computers Engineering Dept. at the Mustansiriyah. His recent research activities are The Challenge of performance E-government by using Worldwide Interoperability for Microwave Access, Routing Algorithm of Simulated Clustering WSN, LDR Sensor Method For Solar Cell Tracking System. Now he is a lecturer at the Mustansiriyah University, college of Engineering, Iraq.*
*Orcid-0000-0002-1395-0668.*

***ALAA HUSSAIN ALTIMIMY****, Date of Birth: 1956 in Thikar, Iraq. He receives B.Sc. in Electrical Engineering/Computers, from University of Basrah, Iraq 1979 and receives M.Sc. in Electronic Engineering, from the University of Technology, Baghdad, Iraq 1989. He worked as a system analyst, team support, and manager in NCEAC from 1985 to 1996. He joins many Universities in Libya, Baghdad, Basra and, Mustansiriyah as a lecturer from 1998 to 2019. His recent research activities are geometry, coverage, connectivity and routing techniques in the wireless sensor networks.*
*Orcid-0000-0001-8499-5823.*