LINEAR DIRECTIONAL WEIGHTAGE BASED ROUTING PROTOCOL FOR MOBILE WIRELESS SENSOR NETWORKS (LDWBR)

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***Abstract*— A WSN is a large-scale network which consists of distributed sensor motes used to track and sense the environment around us and collect the information and transfer it to the sink or base station (BS). These motes or sensors used to gather, group, and transmit the processed data. WSNs are generally deployed in problematic locations and these sensor motes are battery powered and non-rechargeable. Hence, there are lots of restrictions like energy consumption, communication and survival time of network. Since it's significant that the amount of energy consumed by sensors in transferring of data from one node to other, it is important to transfer the data efficiently from one node to other in the networks. In this regard, efficient routing protocol must be designed in order to consume the energy in an optimized manner. In connection to this, this paper includes a general routing algorithm called as linear directions and weightage-based routing technique, which helps to route the data efficiently between the sensor and the sink.**

Keywords — *Routing, Base station, MWSN, LDWBR, network lifetime, packet delivery ratio.*

I. INTRODUCTION

Generally, in all the recent applications like smart transportation, smart grid and intelligent infrastructures which embedded with the concepts of (IoT) internet of things using the sensors as an intermediate small minute device for data aggregation and processing. In these networks these sensors are grouped together and work in a network fashion to transfer collected measured value and control information through distributed WSN.As a one step ahead the newer extension of the WSN is the MWSN Mobile wireless sensor network. The challenging thing in the MWSN is its more critical comparing to static WSNs. The reason behind this is the MWSN has to adapt different topology as the topology of the network changes with time. We have many more application related to MWSNs are healthcare, agriculture, industrial and habitat surveillance [1][2][3].

In the MWSNs we have important problems to be focused like cost of the hardware used, architecture of the entire system, size of the battery and memory used, speed of processing, multi topology, and movement of the sensor node, area coverage and protocol model [4][5].

In the MWSNs there are two different strategies followed, the one which has moving sink devices and sensor nodes as static and the other is where sensor nodes are with mobile in nature and sink devices are static examples are the agriculture field which consists of numerous sensors which collects information of the field like temperature and humidity. In the second strategy where the static sink used to gather data about the moving animals within its coverage area called as habitat monitoring. Sensor nodes which of mobility in nature contains various elements like central micro controller, different forms of sensors (i.e., temperature, pressure, light, humidity, mobility, etc.,), a battery powered radio transceiver [6-8]

Normally the motes are implemented and used in various fields like agricultural lands, submarine places [9,10] and with homogeneous and heterogeneous in nature. In the homogeneous architecture where the sensor nodes posses similar properties and in the heterogeneous architecture where these each sensor node posses different properties like transmission range, battery size, computation ability, memory capacity, range of sensing etc.,[11].

The mobile nature of MWSNs which imbibes and additional constraints as challenges that to be faced like, construction of advanced routing algorithm which focuses on different changing topology, mobility of sensor nodes and other sub constraints like energy consumption, availability of the resource, diversification in computation, memory and range. Hence this paper focuses on few of the problems in relation with routing of MWSN, to increase the stability of WSN based on mobile sensor nodes with different placement positions. The remaining part of the paper structured as follows section III covers the literature review, in relation with WSN, section IV discusses the proposed LDWBR algorithm, and section V shows the performance measurement of the proposed algorithm and section VI gives the conclusion of the paper.

II. LITERATURE SURVEY

This literature review covers the feature of topology & routing in MWSN. The working nature of MWSN is based on transmission reliability, connectivity of different sensor nodes, data gathering, mobility of the sensor nodes and topology [12].Hence to construct an efficient routing algorithm for MWSNs, the mobile nature of sensors & topology are playing an pivot role, while the structure of topology gives the efficient network & QOS in regards with management of traffic & mobility property provides the working picture based on their mobility routing [13,14].Different forms of topology of the network is

followed, where the nodes are added to the existing structure or removed based on the requirements, to attain the best in class efficiency and to define reliable data collection, various forms of network topologies are implemented like structured, unstructured, mesh, chain, tree, hybrid and clustered [6,15].In order to decrease the total number of hops between source node and the sink node, efficient modelling of MWSN is needed to decrease the latency. Mostly the mobility pattern of design which could decrease the efficient data transmission to the sink nodes therefore results in making the routing protocol as complex one [16 – 18].

As we have different mobility pattern applied to the sink node or the sensor node of the network, depends on the environment of the MWSNs, by defining the mobility of sensor patterns either as dependent or independent one [19].

Routing of data plays a pivot role in MWSN, as it involves a significant role in defining a path between sink and the sensor nodes. Therefore one of the important works of routing algorithm is defining the path between the sensor nodes of the entire network and path between the sink and sensor node. The MWSNs should be focused properly in terms of different challenges and constraints [20, 21]. Normally, we have some different forms of routing protocols based on network topology and its application, which states that no any individual routing strategy could be a best one and used for different WSN applications[22, 23].Therefore , we have some different routing protocols like topology based, path-based, operation based [24]. Generally, the routing protocols are based on network topology and subdivided based in location, flat, hierarchical, and multipath [25].Where as under the path establishment category consists of protocols like proactive, hybrid, and reactive based [26].

In the structure based strategy, the flat-based, routing is employed in some big sized networks with lot of sensor nodes, where we have a problem of assigning IDs to each and every node of the network [27].This results in other strategies like data-centric, where all the sensor nodes are treated equally & performs similar routines like flooding [22], gossping [28], directed diffusion [29], rumor routing [30] etc.

In this paper, the proposed routing algorithm depends on the position based information of the sensor nodes, to define the path between the sink devices and source nodes. It is assumed that these types of location based or position based routing protocols, use some miniature GPS modules or it may use some localization schemes in a distributed network based on RSSI (Received signal strength indicator).Therefore in the location based protocols [31, 32], sensor nodes maps their neighbor nodes using message like “Hello”, which could decrease the communication flooding problem, examples of location based routing protocols are:

Geographic Energy aware routing: In this protocol, it uses measurement value based on energy aware concepts to choose the nearest neighbours and manage the energy efficiently and increase the survival time of the network [33].

Adaptive face routing: It’s a routing protocol based on ad hoc concepts & Euclidean planar graphs, here the nodes are segregated into areas called faces. This protocol uses faces to transmit the data through the nodes [34].

Mobility aware routing [35]: Here in this routing protocol, the hierarchical methodology been used and divided the entire network into hierarchical grids and CH. Based on the least mobility value the CH is chosen.

Geographic robust clustering(GRC)[36]: Here in this protocols, the cluster based approach will be followed and the selection of CH based on residual energy & position of the node, and it also has inter cluster communication concepts to recover from the packet loss during data transmission.

III. PROPOSED METHODOLOGY

Equally spatially arranged nodes in the WSN, to show the linear representation a straight line is drawn between source node and sink node. If the next hop is nearest to the straight line, then the corresponding hop will be chosen as the next hop. If the next hop is little bit far-away or far-away or more far-away from the straight line then first little bit far-away will be chosen or if it is far-away then based on the weight from the straight line will be calculated, if the weight is lesser comparing to the other node, then the corresponding node will be chosen as the next hop. If the next hop is more far-away from the straight line, the corresponding node will be omitted. As per the Figure 1, between the source node and the next hop node present in the straight line. We have two possibilities one on the left and the other on the right, while comparing the weights of both the left & right path, the right path seems to be with less weight, so the right path will be chosen instead of the right path.
Figure 1. Here the aggregate weights will be calculated between the source node & next hop present on the straight line. Here we have two possibilities one on the left and the other on the right, the aggregate weights of left path is 22 and the right path is 19, so the right path is chosen instead of the left path.

In this paper a position based routing protocol named LDWBR is proposed. This protocol provides linear directional based routing approach that searches the route dynamically to the sink even due to sensor nodes dynamic mobility pattern and varying topology of the network. Normally the data packets are routed using a particular shortened zone, and the competing neighbour nodes that positioned within the routing limit zone are defined by a least weight of the node which is nearest to the linear direction marked between the source nodes to the sink node.
Here in this paper to explore, the routing strategy. We assume a wireless sensor network that consists of one sink and N mobile nodes with a similar speed in mobility(Vm/s), and all

the nodes using random direction in movement, sink is positioned at some fixed point(Xn,Yn).

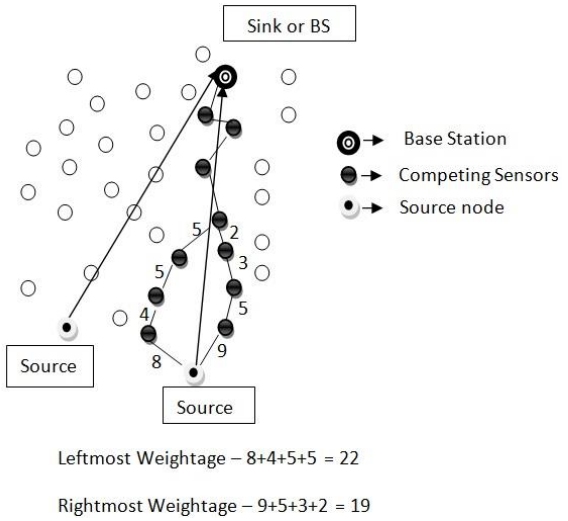

Fig. 1. LDWBR

We assume that the GPS or similar technology is used to identify the location of mobile sensor nodes in the network and the sensor nodes are using the IEEE 802.15.4 as a communication standard for transferring of data packets between the source node and the sink node and the QOS of the transferring signals is measured based on the received quality of the signal. The selection of the next hop during the data transfer process decides the best path between the source node and the base station, however we already have different routing mechanism and strategy for routing data packets, here in this paper, we have used a linear direction as a path and next hop selection based on the weightage that gives efficient routing of data between the source node and the sink node. The selections of the next hop in the data communication process are based on the path discovery phase and hop selection and data discovery and hop selection phase.

In this path discovery phase we are following process of selection of source node and the sink node, and using a methodology called as linear directional, a straight line will be marked between the source node and the base station. The linear straight line must be drawn properly in order to get the exact straight linear path between source node and the base station, for this the centre point of both the source node and the base station were chosen and the linear straight line are marked.

In the next phase, the selection of competing nodes will be done, and among the competing nodes, We have to choose the least weightage sensor node, for this the node with least distance between the centre linear line and the sensor node will be calculated and based on the least weightage value the sensor node will be selected and the next thing to consider here is the distance between the source node to next hop node and consecutive next hop node will be calculated and among those values, the least distance values will be selected for the next hop selection. Though the next hop competing node is nearest to the source node, but if it poses a low residual energy comparing to the other nearest neighbouring competing node, then the sensor node with low residual energy will be ignored and the other neighbouring competing node will be selected based on the above constraints and parametric value.

Algorithm 1

Pseudocode of path discovery phase
Input : node Nid, S_node(x,y), BS(x,y)
Output: To find the linear path in the specified range

```
For i□ 1 to N // N is the total number of nodes in the WSN
Nid□ N_Cur  // Current node ID
Bsid □ B_Cur  // Current BS ID
J  □ mid_point_Nid  // Selection of mid point of node
K □ mid_point_Bsid // Selection of mid point of BS
End For
For i □ 1 to N
i = j
i < = k, i++ ;  line(x1,y1,x2,y2)
End For
```

Algorithm 2

Pseudocode of next hop selection phase
Input : node Nid, S_node(x,y), BS(x,y)
Output: To find the best route between the source node and the BS

```
For i □ 1 to N // N is the total number of nodes
Nid □ N_cur  // Nid is the current node
Bsid □ BS_cur  // Bsid is the current BS
Nid(dist) □ Nid
Bsid(dist) □ Bsid
End For
Wt □ (Wt (Nid1, Nid2)) // calculation of weight of each node
If Wt ( Nid1 <  Nidn ) // Comparison of weigthage value of competing node
then
Nid1
Else
Nidn1....nn
End If
If dist( Nid1 < Nid n)  // Comparing the distance of each node from competing node
Then Nid1
Else
Nidn1...nn
End if
For i□ 1 to N
While( i <= Bsid)  // Choosing the least weight & least distance as routing path
Best( Wt ( Nid1)) && Best ( dist(Nid))
Then
Nid
End While
End For
```

Table 1. Simulation results for LDWBR

Table 1		
Parameter	**Variable**	**Value**
Deployment area	-	100 m X 100 m
Number of nodes	N	500
Sink location	BS	(x,y)
Data packet size	Dp	1000 bits
Control packet size	Cp	100 bits
Initial energy	Ei	2 J
Tx & Rx energy	Etr	50 nJ/bit
Nodes mobility	m	5 m/s

IV. SIMULATION PARAMETERS

Table 1: The simulation for the proposed LDWBR protocol is done using MATLAB tool, for the simulation process, the total number of nodes used is around 500 deployed in an network area of standard size is (100 X 100)m. Here all the transmission process follows single source to single destination combination, with dynamic multi point mobility model followed to fetch the node locations. The packet size used is 1000 bits for both the data and control packets.

V. SIMULATION RESULTS

The performance evaluation process of the LDWBR protocol is based on criteria like lifetime of the network, power consumption, and data transfer rate and routing path length. Thus the protocol is compared with the standard routing protocols: T-LEACH [37], DDR [39] and routing protocol based on area [38].T-LLEACH protocol proves as an improvised version of LEACH protocols and face mobility issues in mass area with random distribution of sensor nodes with mobility pattern-LEACH protocol uses tree based routing strategy with improves energy management techniques and transmission using multiple hop to increase the rate of delivery and energy usage. The area-based protocol routing uses the entire region between the source node and the Base station to create a zonal area for packet transmission and implement a sleep and wakeup strategy to save energy. The DDR based protocol [39] uses mobility based information like location of the node, speed of the mobility node and its direction, along with other factors like low data transmission rate with best path between the source node and the Base station. Whereas the proposed LDWBR routing protocol implements a linear directed weightage based routing mechanism for the mobility based nodes and provides efficient path discovery phase and hop selection phase in order to search a better path between the targets which proves better performance in routing and data delivery rate.

VI. NETWORK LIFETIME

Figure 2. For the proposed LDWBR protocol, the network lifetime is calculated, based on number of active sensor nodes over the number of rounds for the DDR protocol the network lifetime starts decreasing after 4500 rounds and for the T-LEACH and protocol based on area the network lifetime starts decreasing after 4000 rounds. Comparatively for the LDWBR protocol the network lifetime start decreasing after 5000 rounds. Concerning the dead nodes of the MWSN, all the nodes are dead for LDWBR only after 10000 rounds, whereas for the DDR, it is 9000, T-LEACH it is 8000 and for the area-based protocol it is 6000, which shows that 11%, 25% and 67% increase in the survival time of the network while comparing with DDR, T-LEACH, area-based routing protocol.

This shows that our LDWBR protocol selects the best hop for data delivery process, which in turn chooses the shortest path by selecting the best competing nodes and ignoring the non-competing nodes ultimately results in better utilization of network resources and gives better increase in the nodes lifetime of the networks.

VII. DATA PACKET DELIVERY RATIO

The second parameter chosen to assess the routing protocols is data packet delivery ratio, calculated based on number of data packets transmitted by the source node to number of data packet received successfully by the receiving node.

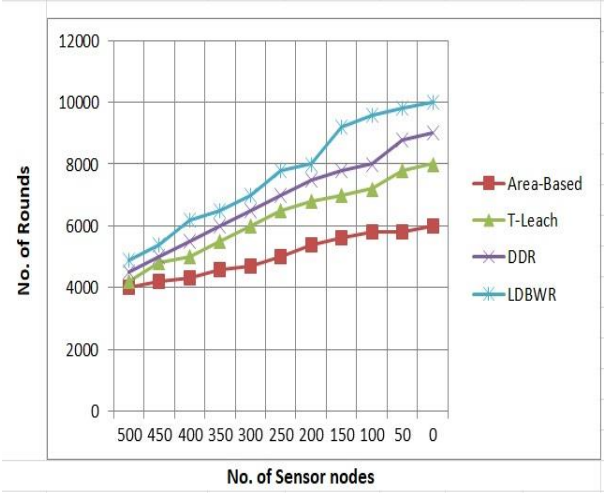

Fig. 2. Comparison of Network lifetime

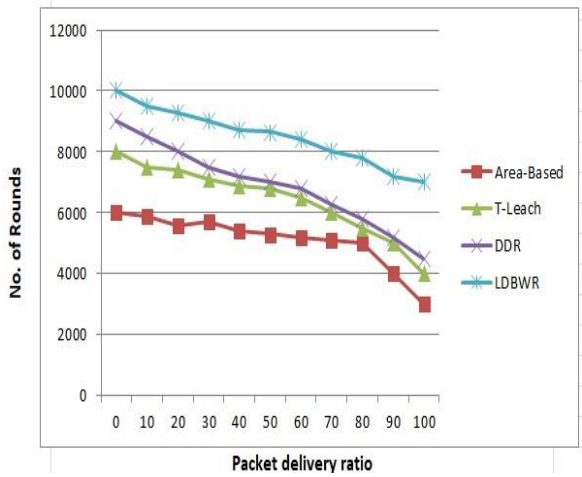

Fig. 3. Packet delivery ratio

In our simulation process, we measure the data delivery ratio based on number of packets transmitted by a particular sensor node at each round to the number of packets received by the sink in each round, then we calculate the percentage of data delivery ratio based on number of packets delivered successfully to the sink node at each round.

Figure 3. Shows the data packet delivery ratio for all the four protocols and it were clearly shown that the LDWBR protocol provides higher packet delivery rate. The figure depicts that there was 100 packet delivery rates for all the 4 protocol for the first 3000 rounds, based on the high number of alive nodes. After certain period, the number of dead nodes increases and the protocols started to show decrease in the performance ratio, with LDWBR offering around 95% delivery rate at round 7000, whereas the DDR, T-LEACH and area-based protocol provides delivery rate of 80% and 20%.Due to more number of alive nodes in the network in case of LDWBR protocol, a better packet delivery rate is been achieved.

VIII. CONCLUSION

In this paper we proposed a novel protocol for a better routing process in mobile wireless sensor networks. The search for next hop node starts from the source node using linear directional weightage based routing where the best next hop node selected based on linear straight line and weightage calculated by calculating the distance between the line and the competing next hop node and choosing the least weightage node for the data transmission process and also considers the residual energy as an additional parameter for choosing the next hop node for the packet delivery between the sensor node and base station. The results obtained from the two parameters the survival time of the network and packet delivery rate proves the efficiency of LDWBR with 67% increasing in network lifetime and 15% increases in the packet delivery rate compared to other routing protocols DDR, T-LEACH and area-based protocols.

References

[1] R.S. Sudha, A survey on wireless sensor networks, Int. J. Eng. Sci. Res. Technol. (2017) 66–71.

[2] K.K. Kaur, Parneet, S. Singh, Wireless sensor network: architecture, design issues and applications, Int. J. Sci. Eng. Res. (IJSER) (2014) 6–10.

[3] S.R. Prasanna, Srinivasa, An overview of wireless sensor networks applications and security, Int. J. Soft Comput. Eng. (IJSCE) (2012) 538–540.

[4] A.K. Priyanka, Singh, A survey on applications, communication stack and energy consumptions in WSNs, Int. J. Recent Technol. Eng. (IJRTE) (2019).

[5] T.B. Bala, Varsha, S. Kumawat, V. Jaglan, A survey: issues and challenges in wireless sensor network, Int. J. Eng. Technol. (2018) 53–55.

[6] M.A.I. Matin, Wireless Sensor Networks Technology and Protocols, M M, Intechopen, 2012.

[7] S.K.S. Gupta, Poonam, Overview of wireless sensor network: a survey, Int. J. Adv. Res. Comput. Commun. Eng. (2014) 5201–5207.

[8] P.R.C. Gundalwar, A literature review on Wireless Sensor Networks (WSNs) and its diversified applications, Int. J. Adv. Res. Comput. Sci. (2012) 120–128.

[9] L S.F. Chelouah, L. Bouallouche-Medjkoune, Localization protocols for mobile wireless sensor networks: a survey, Comput. Electr. Eng. (2017) 1–19.

[10] C.Y.-C. Wu, Heterogeneous wireless sensor network deployment and topology control based on irregular sensor model, in: Second International Conference on Grid and Pervasive Computing, Paris, France, 2007.

[11] R.H. Sankar, S. Venkatasubramanian, A study on next generations heterogeneous sensor networks, in: 5th IEEE GCC Conference & Exhibition, Kuwait, 2009.

[12] A. Sharma, Study of different network topologies, Int. J. Res. Publ. Semin. (JRPS) (2016).

[13] K.H.B. Krishna, Y. Suresh, T. Kumar, Wireless sensor network topology control using clustering, in: 7th International Conference on Communication, Computing and Virtualization 2016, 2016, pp. 893–902.

[14] A.V.P. Nagpure, Sulabha, Topology control in wireless sensor network: an overview, Int. J. Comput. Appl. (IJCA) (2014) 13–18.

[15] V. Ramasamy, Mobile wireless sensor networks: an overview. Wireless Sensor Networks - Insights and Innovations, IntechOpen, 2017.

[16] T B.J. Camp, V. Davies, A survey of mobility models for ad hoc network research, Wireless Commun. Mob. Comput. 2 (2002).

[17] V R.K.M. Vasanthi, A. Ajith Singh, M. Hemalatha, A detailed study of mobility models in wireless, J. Theor. Appl. Inf. Technol. 33 (2011) 7–14.

[18] R Z.Z. Silva, J.S. Silva, V. Vassiliou, Mobility in WSNs for critical applications, in: IEEE Symposium on Computers and Communications (ISCC ‘11), Corfu. Greece, 2011, pp. 451–456.

[19] R. RR, Handbook of Mobile Ad Hoc Networks for Mobility Models, Springer, 2011.

[20] N.B. Malik, Anju, Literature review on protocols for wireless sensor networks, J. Netw. Commun. Emerg. Technol. (JNCET) (2017) 17–22.

[21] K.P. Mehta, Raju, Energy efficient routing protocols for wireless sensor networks: a survey, Int. J. Comput. Appl. (IJCA) (2017) 41–46.

[22] L.K.Z. Ketshabetswe, A. Murtala, M. Mangwala, J.M. Chuma, B. Sigweni, Communication protocols for wireless sensor networks: a survey and comparison, Heliyon (2019) pp. 1-43.

[23] V.C. R.P. Biradar, S.R. Sawant, R.R. Mudholkar, Classification and comparison of routing protocols in wireless sensor networks Ubiquitous Comput. Secur. Syst. J. (UbiCC) (2010) 704–711.

[24] S.G. Kaganurmath, Evaluation of routing protocols for wireless sensor networks, Int. J. Comput. Commun. Technol. (2016).

[25] M.D. Radi, Behnam, K.A. Bakar, M. Lee, Multipath routing in wireless sensor networks: survey and research challenges, Sensors (2012) 650–685.

[26] A.M. Sarkar, Senthil, Routing protocols for wireless sensor networks: what the literature says? Alex. Eng. J. (2016) 3173–3183.

[27] S.S.H. Arathi, Flat based network routing protocol in wireless sensor network, Int.J. Eng. Res. Technol. (IJERT) (2015).

[28] C.D. Choksi, Bijon, Comparison of routing protocols in wireless sensor networks, in: International Conference on Computer Science and Information Technology, 2012, pp. 17–23.

[29] C.G. Intanagonwiwat, Ramesh, D. Estrin, Directed diffusion: a scalable and robust communication paradigm for sensor networks, in: 6th Annual International Conference on Mobile Computing and Networking, 2002, pp. 56–67.

[30] H.B. Echoukairi, Khalid, M. Ouzzif, A survey on flat routing protocols in wireless sensor networks, in: International Symposium on Ubiquitous Networking, 2016, pp. 311–324.

[31] S. Giordano, I. Stojmenovic, L. Blazevic, Position based routing algorithms for ad hoc networks: a taxonomy, Ad hoc Wirel. Netw. (2003).

[32] I. Stojmenovic, Position-based routing in ad hoc networks, IEEE Commun. Mag. (2002) 128–134.

[33] Y. Yu, R. Govindan, D. Estrin, Geographical and Energy Aware Routing: A Recursive Data Dissemination Protocol for Wireless Sensor Networks, UCLA Computer Science Department, 2001.

[34] F. Kuhn, R. Wattenhofer, A. Zollinger, Asymptotically optimal geometric mobile ad-hoc routing, in: 6th international workshop on Discrete algorithms and methods for mobile computing and communications, 2002, pp. 24–33.

[35] J.N.K. Al-Karaki, E. Ahmed, Routing techniques in wireless sensor networks: a survey, Wirel. Commun., IEEE (2005).

[36] C L.M. Arboleda, N. Nasser, Cluster-based routing protocol for mobile sensor networks, in: 3rd international conference on Quality of service in heterogeneous wired/wireless networks, 2006.

[37] J. Hong, J. Kook, S. Lee, et al., T-LEACH: the method of threshold-based cluster head replacement for wireless sensor networks, Inf. Syst. Front. (2009).

[38] R.S.V. Sreejith, N. Vyas, K.R. Anupama, L.J. Gudino, Area based routing protocol for mobile wireless sensor networks, in: 32nd International Conference on Information Networking (ICOIN), 2018.

[39] Reham almesaeed, Ahmed Jedidi , Dynamic directional routing for mobile wireless sensor networks, in :Ad Hoc Networks, Elsevier 2020.