COMPARATIVE STUDY OF ENERGY EFFICIENT CLUSTERING AND ROUTING BASED OPTIMIZATION AND LOCALIZATION TECHNIQUES IN WIRELESS SENSOR NETWORKS

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***Abstract*— Wireless Sensor Networks (WSNs), the localization has been generally used for classifying the current location of the sensor nodes. Since numerous of sensor nodes are available in WSNs, it is virtually impossible to connect global positing system on every sensor node, as it is higher. it is not possible to organize the location position physically on every sensor node. WSNs placement is made commercial by means of localization methods. This paper describes about energy-efficient clustering and routing techniques based on an improved optimization and localization techniques. In clustering and routing techniques, the location of sensor deployment effects the effectiveness of data communications. Optimization techniques used in WSNs for increasing energy consumption. The energy efficiency, sensor node deployment, stability period and network lifetime are important constraint in WSNs. In this paper discuss on localization process in WSNs using energy efficient routings techniques. And also give knowledge to the researchers to develop effective algorithms to node deployment with precision to many techniques. Finally, this paper addressed the intended classification framework of a comparative analysis on the optimization techniques and different localization techniques.**

Keywords — *Sensor Networks, Routing, Cluster, Optimization techniques and Localization Techniques.*

I. INTRODUCTION

Sensor networks have numerous sensor nodes accomplished of sensing the environment features and communicated them to the base station. The WSNs nodes can detect monitor the environment conditions, and forward the collected data to the other sensor nodes. Numerous technologies like transmission and digital electronics which consume allowed the design method of a different sensors with minimal energy and cost, lightweight sensor nodes. The sensor nodes work on a low capacity power [1]. So, the energy of all the sensor nodes must be optimally used in the real applications. The network lifetime and stability period of the WSNs is the full functioning period straight associated with the sensor energy. Sensor networks must display an optimal performance with low delays and produce the consistent data with a low energy consumption in order to give correct information for high stages. However, energy consumption can develop a main problem because of the sensor minimum battery power [2]. Clustering method gives an eminent result to the energy issues in WSNs. Clustering splits the complete sensing zone into the desired series of sub zones then, cluster head node is select based on energy consumption of sensor node. Cluster head nodes are important for collecting the neighbour's sensor node information, aggregating the collected data, and communicating the accumulated information to the base station [3].

The base station node develops the cluster head for the transmission and time division multiple access schedules. The cluster head sensor node also produces a time division multiple access for the sensor node's data Communications [4]. Sensors nodes are arranged in such a manner that they have minimum resources like energy and transmission capacity. Initially each sensor node has minimum amount of energy but as the communication takes place, energy becomes expand. So, increasing network lifetime stability period and energy consumption are important challenging tasks in a WSNs. path determination in WSNs is a major problem and many researchers are finding the best possible path for increasing the performance of a WSNs. The routing-based energy efficient is an important challenge. For resourceful transmission to take place, a routing protocol is desired among sensor nodes of a WSNs to require a route among a source sensor node and a destination sensor node. Routing protocols will set up best paths for the data transmission to take place among sensor nodes and the base station. These efficient routing paths are predictable to optimize the network lifetime. The various protocols for best energy efficient routing are intended to allocate the load among all sensor nodes, thus decreases the energy consumption in a WSNs [5].

The important goals of a WSNs are to monitor the selected places, aggregated the real time data using sensors and transmit the aggregated data to the base station in efficient ways based on essential parameter [6]. Fig1 shows the structure of optimization and Localization techniques in WSNs. In this paper describes the literature review, Clustering techniques, routing techniques, Optimization Techniques, and localization techniques and Comparison of optimization and localization techniques based on energy efficient routing and clustering techniques.

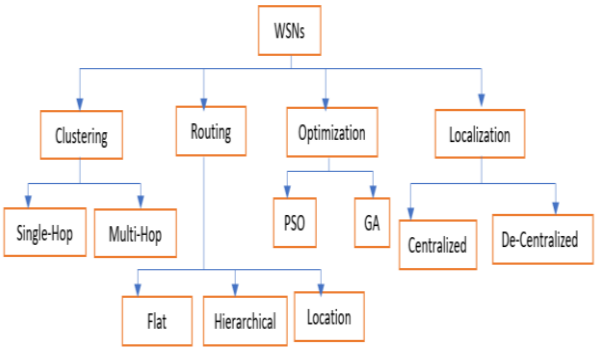

Fig. 1. Structure of Optimization and Localization techniques in WSNs

II. LITERATURE REVIEW

Soumya J. Bhat et.al (2020) This paper proposed a comparative analysis of localization techniques. Mainly discussed about importance about sensor node localization in unbalanced fields and Existing localization techniques. Taxonomy framework used for comparative analysis of different localization techniques in unbalanced fields and optimal based localization techniques [7].

Jeng-Shyang Pan et.al (2020) This paper explained about artificial intelligence and solution of node localization problem using optimization algorithm. This paper proposed a hybrid algorithm based on whale optimization and quasi-affine transformation evolutionary algorithms. The WOA and QUATRE algorithms are used for optimize the WCL and RSSI algorithms. This paper selects many benchmark functions, experiments from different positions. The simulation results show that the WOA-QT optimization quality and efficiency [8].

Dr. Wang Haoxiang et.al (2020) In this paper proposed a Soft Computing Approaches for Optimized Route Selection. This paper mainly focused on evolutionary algorithms performance analysis of Genetic algorithms, Particle swarm optimization, Ant lion optimization and Ant colony optimization. Fuzzy Petri Net model helps to evaluate the route in wireless sensor networks. The simulation results show the energy efficiency, network lifetime and packet transmission ration of optimal paths [9].

Sridhar R et.al (2020) this paper proposed a chaotic whale metaheuristic energy optimized data gathering (CWMEODG) for data gathering in energy efficient manner. The Chaotic tent map mathematical model used in CWMEODG techniques. This technique helps to find the global optimum solution and fast convergence rate. The simulation results show CWMEODG techniques performance of energy consumption, data packet delivery ratio, data packet loss and delay discussion. This technique progresses the energy efficient high-level packet transmission and minimal packet loss [10].

Y. Harold Robinson et.al. (2019)., proposed a Probability-based fuzzy multi path routing and CH selection for increasing lifetime in WSNs. This algorithm performs improve the energy efficiency based on threshold value. This protocol used to measure the energy, base station distance, selection of cluster head and provides the efficient routing for sensor nodes. Simulation result shows the better performance of energy efficient cluster-based routing protocol method improves in terms of Energy comparison, Network life time, Computation overhead, Delivery Ratio, Delay comparison [11].

III. CLUSTERING TECHNIQUES IN WSNS

In the clustering method, routing is communicating the data to the base station sensor node in the clustered framework. The network has many clusters group. Every cluster has a tree containing of a cluster head and cluster member sensor nodes. The environmental information collected by the cluster member nodes and the cluster member nodes communicating to the cluster head sensor node. The cluster head sensor node collecting the information and send to the base station node [12].

This method enhances the cluster head selection based on the sensor residual power of and sensor deployment. Routing method combined for the data aggregation process and optimal routes from the cluster head to the base station.

IV. ROUTING TECHNIQUES IN WSNS

The numerous challenges in routing techniques of WSNs and select the best ways to address these problems using optimization techniques. The important goal of the routing techniques is to study the present state of the optimization techniques used in routing information through WSNs and classify efficient methods for routing in a WSNs.

Many routing protocols are developed according to the strategy of decreasing energy consumption to increase the sensor networks lifetime with minimum overhead costs [13].

1) Flat Protocol: Senor nodes are arranged consistently and consume few parts. Each sensor node is at equal level exclusive network. Flat protocols can be divided as proactive, reactive and hybrid protocols [14].

2) Hierarchical Protocols: These protocols nodes are deployed into clusters and sensor node consuming high energy becomes cluster heads of the cluster. Cluster head node aggregates actions exclusive and exterior cluster. Cluster head is responsible for aggregating information from sensor nodes of their cluster and eliminating redundancy between gathered data to decrease the energy condition for communicating of data from cluster head to base station. Example Protocol: Low Energy Adaptive Clustering Hierarchy (LEACH), Stable Election Protocol (SEP), Threshold sensitive Energy Efficient sensor Network protocol (TEEN).

3) Location based Protocols: Sensor nodes are distinguished on source of their position inside network. Position between sensors nodes are considered on basis of signal strength, higher and lower the distance among senor nodes. Some protocols in this group permit sensor nodes to go into sleep mode if there is no motion working on at that

sensor node. Example Protocol: Geographic and Energy Aware Routing (GEAR) and Greedy Perimeter Stateless Routing (GPSR) [15].

V. DESIGN OF ROUTING PROTOCOLS

1) Node message delivery strategy: Sensor nodes are placed on the base of application in WSNs. It has two types: Deterministic and Ad-hoc. in deterministic the nodes are physically deployed and communicate the data with the decided path, while In Ad-hoc, the placement of sensor nodes is casually distributed [16].

2) Data reporting method: According to many applications, data delivery technique can be four types: Time-Driven Method, Event-Driven Method, Query-driven Method and Mixed-mode Method [17].

3) Network dynamics: The design of sensor nodes in greatest wireless network manners is motionless, but in detail the base station sensor node is active, and the challenges of different approaches will give a result on research goal whether dynamic or stationary.

4) Node localizations: Sensor node localization management is important issues on developing routing protocols. In localization routing protocols is significant to confirm the sensor nodes placement. The aggregated information is communicated between sensor nodes [18].

5) Fault-Tolerance: The sensor nodes are unsafe, once the sensor node is energy dead, the routing protocol is able to distinguish the positions of nodes.

6) Node nature: The energy consumption and memory are constant for sensor node, so the routing algorithm would be light weighted and humble [19].

VI. OPTIMIZATION TECHNIQUE IN WSNS

The Optimization is desirable to generate a well efficient strategy as per the parameters. Network optimization is helpful for attaining desired goal that low energy consumption or increase the network lifetime and stability period. In a WSNs, energy consumption, network lifetime, stability period, packet transmission and security are some of the importance problem in routing [14].

Sensor Networks has several requirements in many applications. The main WSNs requirements that have initiate are scalability period, quality of service (Qos), security measures, mobility nods and robustness. The low energy consumption in WSNs works has implemented different studies in past years. These literatures mainly focused on the routing algorithms, multiple access protocols, carrier sense multiple access protocols and transmission control etc. Among many research issues in WSNs attention problem expressively affects performance of network, which describes how well sensors monitor a sensor deployment fields by their detecting capability. Sensor nodes increases fault tolerance and network lifetime [20]. In WSNs the sensor nodes can stop sensing due to real time environmental conditions, physical injury, or minimum energy of sensor node. Therefore, due to fault of sensor nodes performance or working of sensor nodes must not affect. And it is named as the consistency or fault tolerant problem. Although it is extremely impractical to retain all the sensor nodes active for the data aggregation determination, as huge number of sensor nodes can encourage advanced energy consumption as well as generating bottleneck problem in the network [21]. In this situation the objective is to keep less nodes working to ensure high attention or complete attention of sensor nodes. It indicates by estimating the network area attention when sensor networks efficiency is calculating. WSNs has several interesting problems that are required to estimate and optimize with several requirements. The main issues such as sensor arrangement, localization, clustering, routing, cluster head node deployment, data aggregation. The Particle Swarm Optimization (PSO) algorithm mainly helpful for maximizes the Energy consumption and data transmission. Genetic Algorithms (GA) typically used to resolve search and optimization issues .GA algorithm contains of a group of characters which are called as chromosomes. Chromosome defines search area on several facts [22].

Energy optimization requirements of WSNs are one of the most eminent issues meanwhile it decides on the sensor node location and improves accurate data communication rate. Based on the numerous wireless network methods shows, it has been noted that they come across bottleneck and network losses; there is also presence of unorganised deployment in the wireless sensor network model and thus it tends to decrease the network life time and increases delay in data communication rate [23].

VII. LOCALIZATION TECHNIQUES IN WSNS

The localization protocols are classified as range-based protocols. A range-based localization protocol activates mostly by determining distances between correct reference points and incorrect reference point nodes [24]. Table 1 shows the Comparison of Localization and optimization approach using cluster-based techniques [15], [25].

Localization techniques act a significant part, and it desires to be measured in finding the correct location of a sensor node. The mostly used types of localization system are distributed system and centralized system. localization is a technique of finding relative and absolute location data of sensor nodes within the deployed sensor fields of attention. It is important conditions in WSNs. Important requirement of node positioning information is required along with event aggregation in many real time applications. It will be helpful in developing of many networking techniques such as clustering, routing, transmission, network attention, etc. Sensor node location data can be useful in increasing network monitoring and detecting task and also helpful in real time target identification applications such as in battle field areas [26].

The main mechanisms of localization technique are identification and data transmission, quantity and data attainment and computation of sensors position. localization techniques goal to attain the following purposes:

1) Large coverage: By confirming that many of the sensor nodes are able to find their location data.

2) Low transmission overhead: Location data of the nodes must be assessed using a minimum number of information to save network power and decrease channel bottleneck problems.

Table 1. Comparative study on various cluster-based Localization and optimization approach

Techniques	Node Density	Mobility	Energy Efficiency	Data Transmission	Accuracy
LEACH	Medium	Medium	Low	Medium	Medium
SEP	Low	Medium	High	Medium	Medium
TEEN	Medium	Low	Medium	Medium	Medium
Centralized based	Medium	High	Low	High	High
Decentralized based	High	High	High	Medium	Low
GPSR	High	High	Medium	Medium	High
GEAR	Medium	High	High	Medium	High

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1) Large coverage: By confirming that many of the sensor nodes are able to find their location data.

2) Low transmission overhead: Location data of the nodes must be assessed using a minimum number of information to save network power and decrease channel bottleneck problems.

3) High accuracy: A localization algorithm can decrease the error in the assessed position information by decreasing the gap among the assessed location and the correct location.

4) Low deployment cost: The arrangement of sensor field maintains and sink nodes or any other different devices used to help in locating sensor nodes can be reasonable and cost effective.

5)Efficient scalability: The difficulty of the localization algorithm can produce efficiently as a strategy of the number of sensor nodes [27].

A. Two Techniques in Localization

1) Centralized Technique: The central base station detects and estimates the distance between all the sensor nodes. After the estimation, the distance is advanced back to the sensor nodes. The communication of data in this procedure is responsible for potential, energy usage and bandwidth. Centralized algorithms are additional precise than distributed networks, since centralised algorithms have a universal view of the complete network. The absence of capacity to access the information in a right way is the result of the progression [28].

2) Distributed Technique: In the distributed localization approaches the sensor nodes gather the capacities with different approaches and control the distance between nearby base station nodes. By networking with all other the sensor nodes become their own location in the network.

IX. CONCLUSION

Many applications WSNs need accurate deployment of sensor nodes to take measures on the information. However, once sensor nodes are located across sensor fields filled with transmission between sensor nodes deteriorates due to diffusion and reduction from problems causing inaccurate location valuations. the localization of sensor networks based on different methods have been discussed in this paper. This paper gives a complete knowledge of localization and optimization techniques. its helpful for researcher can developing valuable algorithms that combine these approaches to exactly place the nodes in network, so that data can be communicate efficiently without interference in the network.

References

[1] Jing WANG, R. K. GHOSH and Sajal K. DAS, A survey on sensor localization, J Control Theory Appl, pp. 2–11, 2010.

[2] Carolina Del-Valle-Soto, Carlos Mex-Perera, Juan Arturo Nolazco-Flores, Ramiro Velázquez and Alberto Rossa-Sierra, Wireless Sensor Network Energy Model and Its Use in the Optimization of Routing Protocols, energies MDPI, pp. 1-33, February 2020.

[3] M. Sridhar and P. B. Pankajavalli, An optimization of distributed Voronoi-based collaboration for energy-efficient geographic routing in wireless sensor networks, Cluster Computing (Springer), May 2020.

[4] Sathyapriya Loganathan and Jawahar Arumugam, Energy Efficient Clustering Algorithm Based on Particle Swarm Optimization Technique for Wireless Sensor Networks, Wireless Personal Communications (Springer), February 2021.

[5] Zaher Al Aghbari, Ahmed M. Khedr, Walid Osamy, Ifra Arif and Dharma P. Agrawal, Routing in Wireless Sensor Networks Using Optimization Techniques: A Survey, Wireless Personal Communications (Springer), December 2019.

[6] Ruchi Aggarwal, Anupam Mittal and Ramandeep Kaur, Various Optimization techniques used in Wireless Sensor Networks, International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 06, pp:2085-2090, June 2016.

[7] Soumya J. Bhat and K. V. Santhosh, Is Localization of Wireless Sensor Networks in Irregular Fields a Challenge?, Wireless Personal Communications (Springer), May 2020.

[8] Jeng-Shyang Pan, Fang Fan, Shu-Chuan Chu, Zhigang Du and Huiqi Zhao, A Node Location Method in Wireless Sensor Networks Based on a Hybrid Optimization Algorithm, Hindawi Wireless Communications and Mobile Computing, Volume 2020, pp:1-14, October 2020.

[9] Dr. Wang Haoxiang and Dr. S. Smys, Soft Computing Strategies for Optimized Route Selection in Wireless Sensor Network, Journal of Soft Computing Paradigm (JSCP) Volume 02, issue 01, Pp:1-12, 2020.

[10] Sridhar R. and N. Guruprasad, Energy efficient chaotic whale optimization technique for data gathering in wireless sensor network, International Journal of Electrical and Computer Engineering (IJECE), Volume 10, Issue 4, pp: 4176-4188, August 2020.

[11] Y. Harold Robinson, E. Golden Julie, Raghvendra Kumar and Le Hoang Son, Probability-based cluster head selection and fuzzy multipath routing for prolonging lifetime of wireless sensor networks, Peer-to-Peer Networking and Applications (Springer), May 2019.

[12] Xingxing Xiao and Haining Huang, A Clustering Routing Algorithm Based on Improved Ant Colony Optimization Algorithms for Underwater Wireless Sensor Networks, Algorithms MDPI, PP:1-18, October 2020.

[13] Mohammed Abazeed, Norshiela Faisal, Suleiman Zubair and Adel Ali, Routing Protocols for Wireless Multimedia Sensor Network: A Survey, Hindawi Publishing Corporation Journal of Sensors, pp.1-11, November 2013.

[14] Prabhat Kumar, M.P.Singh and U.S.Triar, A Review of Routing Protocols in Wireless Sensor Network, International Journal of Engineering Research & Technology (IJERT), Volume 1 Issue 4,pp:1-14, June 2012.

[15] Vishal Kumar Arora, Vishal Sharma and Monika Sachdeva, A Survey on LEACH and other's Routing Protocols in Wireless Sensor Network, Optik - International Journal for Light and Electron Optics, April 2016.

[16] Ms. Parul Tyagi Ms. Surbhi Jai, Comparative Study of Routing Protocols in Wireless Sensor Network, International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 9, pp.134-140, September 2012.

[17] Gherbic.C, Aliouat.Z and Benmohammed.M, A Survey on Clustering Routing Protocols in Wireless Sensor Netiworks, Emerald Group Publishing Limited (emegald insight), pp.1-21, January 2017.

[18] Shio Kumar Singh, M P Singh and D K Singh, Routing Protocols in Wireless Sensor Networks – A Survey, International Journal of Computer Science & Engineering Survey (IJCSES), Volume1, issue 2, pp:63-83, November 2010.

[19] Xiang Yang and Dengteng Deng, Meifeng Liu, An Overview of Routing Protocols on Wireless Sensor Network, IEEE 4th International Conference on Computer Science and Network Technology (ICCSNT), pp: 1000-1003, 2015.

[20] N. Priya and P. B. Pankajavalli, Review and future directions of Fault Tolerance schemes and applied techniques in Wireless Sensor Networks, International Journal of Computer Sciences and Engineering JCSE, Volume 7, Issue 3, pp:599- 606, March 2019.

[21] Surjit Singh and Rajeev Mohan Sharma, Optimization Techniques in Wireless Sensor Networks, ICTCS '16, March 2016.

[22] Ruchi Aggarwal, Anupam Mittal, Ramandeep Kaur, Various Optimization techniques used in Wireless Sensor Networks, International Research Journal of Engineering and Technology (IRJET), Volume 03 Issue 06, pp: 2085-2090, June 2016.

[23] S. Govindaraj and S. N. Deepa, Network Energy Optimization of IOTs in Wireless Sensor Networks Using Capsule Neural Network Learning Model, Wireless Personal Communications (Springer), August 2020.

[24] Tariq Islam and Seok-Hwan Park, A Comprehensive Survey of the Recently Proposed Localization Protocols for Underwater Sensor Networks, IEEE Access, pp:1-24, 2020.

[25] S. Sivasakthiselvan and V. Nagarajan, Localization Techniques of Wireless Sensor Networks: A Review, International Conference on Communication and Signal Processing (IEEE Xplore), pp. 1643-1648, July28 - 30, 2020.

[26] Amanpreet Kaur, Niyati Aggrawal and Sangeeta Lal, An Accurate Localization in Wireless Sensor Networks, IEEE Xplore, October 2020.

[27] Faiza Al-Salti, N. Alzeidi and Khaled Day, Localization Schemes for Underwater Wireless Sensor Networks: Survey, International Journal of Computer Science & Communications (IJCNC), Volume 12, Issues 3, pp:113-130 May 2020.

[28] Sneha and M. Nagarajan, Localization in Wireless Sensor Networks: A Review, BULGARIAN ACADEMY OF SCIENCES, Cybernetics and Information Technologies, Volume 20, Issue 4, pp-1-26, 2020.